POWER

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FOOTBALL is a great game. Many people condemn football, saying, "It is brutal." We must admit ourselves that it *is* a bit strenuous, but so is piano-playing for the man who has a run-around on the tip of each of three fingers.

Well, then, the ayes have it; football is a great game for these reasons:

It teaches discipline and self-control. Every rule of the game must be scrupulously observed, and in the excitement of the moment and anxiety to win, some of them are mighty hard to remember. When you are keyed up to the highest pitch it is not always easy to wait until the ball is "snapped" before you start your lunge at the opposing line. If you do not wait, however, you are "offside" and your team is penalized ten good yards for your over-eagerness—if the umpire sees you. If it happens too often you will find that you are not as great a football player as you thought you were—not near—because the loss due to a penalty of ten yards is greater than the probable advantages of a great number of offside plays.

Football teaches perseverance—stick-to-it-ive-ness. For instance, the ball has been worked down the field until it is on the ten-yard line of one of the teams. Does this team lie down and play dead just because things look dubious? Not by any means. The team puts every last ounce of effort into its play. And often those last ounces are just what is needed, for just as often the tables are completely turned and a well deserved tally is scored.

Football teaches alertness, resourcefulness and that physical fitness is important.

Best of all, football teaches true sportmanship. A successful footballist bucks the line hard, plays fair, puts up when he loses and shuts up when he wins.

We heard that remark! Somebody over there in the back row said, "What in the name of Hocus Pocus has all this to do with operating engineers and their vocation?"

Just this: Football is a whole lot like the game of life; the same things that count in the one count in the other. Those very qualities so essential to a good football player are the same that any man might well cultivate, no matter what his occupation.

In the long run, you cannot win by playing offside, either in football or in operating engineering. You must play square and obey the rules.

You cannot win by being a quitter. Of course, you get up against a tough proposition now and then, but every difficulty that you succeed in overcoming only makes you all the more able to meet the next tough one.

You cannot win by being asleep to your opportunities and possibilities. No one is going out of his way to boost you. You must boost yourself by seeing your chances when they come along, and taking advantage of them.

And, finally, unless you are physically and mentally fit to do the best that is in you, you are not playing fair to yourself or to your team.

Truly, it would be a fine thing if more of us had the advantages of a football training.

Isolated Power for Making Shoes

By W. B. Wilkinson

The machinery in this plant is driven by motors suspended from the ceilings.

Electrical energy is obtained from two direct-current generators, belt-driven from a line shaft.

Power is supplied by a Corliss engine taking steam from two return-tubular boilers.

The newly finished shoe factory of the Julius Grossman Company, DeKalb avenue and Steuben street, Brooklyn, N. Y., is an example of a modern isolated-plant equipment for factory purposes. The company found its facilities limited in the crowded section of New York City. The plant is designed on modern lines conducive to economy in operating costs and overhead charges, and at the same time provides for the comfort and safety of the employees.

Factory Building

The main factory building is 200 feet long and 60 feet wide and the extensions for elevator, toilets and stairways are 20x42 feet each. There is one return extension of the main factory building 30x40 feet, and five stories in hight; the boiler room is 20x42 feet and is one story in hight. The main building is of mill construction with 80 per cent. window exposure. The halls, main stairways, elevator and toilets, also an inclosed fire-escape tower, are all outside of the building proper on an adjoining alleyway, leaving each floor unobstructed for light and ventilation.

A sprinkler system has been installed throughout the building, and is connected to a 25,000-gallon water tank which is located on the roof and supported by a steel framework. A blower system removes all dust from the machines in the factory to a receiver on the roof, from which it is conveyed to the coal vaults in front of the boilers, the refuse being mixed with the coal and burned as fuel.

Modern plumbing has been installed in large separate toilet rooms on each floor, with sanitary walls and floors. A house-supply tank for the toilets is placed on the roof. The elevator and fire-escape towers also open on the roof.

Boiler-room Equipment

The power-plant equipment consists of two 125-horsepower horizontal return-tubular boilers, Fig. 2, built to carry 125 pounds working pressure per square inch. Each furnace is equipped with dumping grates and an auxiliary steam-jet blower to assist in burning low-grade coal and the factory refuse. The boilers are situated in a boiler house adjoining the main building and the boiler room is connected with the engine room, which is on a level with the basement floor. A twin-breeching and smoke-flue connection which is lined with fire tile leads to a brick stack from the boilers; an automatic hydraulic damper regulator regulates the draft. Surface blowoff connections are joined to the blowoff tank, which is set on cast-iron cradles. The blowoff pipe in each combustion chamber is protected by an asbestos covering. A non-return valve is placed on the steam dome of each boiler for emergency use in case of rupture to a steam pipe or fitting, etc. All high-pressure piping and fittings are extra heavy.

An injector is placed in the boiler room to be used as an auxiliary feed to the boilers. Safety water columns with high- and low-alarm whistles are also provided. All drips are connected under the floor to sewer drains.

The underwriters' fire pump is also located in the boiler room with the hose coil, and a hose house is built on the roof of the boiler house.

Engine-room Equipment

Adjoining the boiler room, but in the main building, is a large, well lighted engine room, Fig. 1. A 14x36-inch, 125-horsepower Corliss engine, with a 10-foot flywheel of 22-inch face, rests on a solid concrete foundation, which extends 5 feet below the floor and 12 inches above the floor level. The engine is set at one side of the room and drives a $3\frac{15}{16}$-inch shaft by means of a double belt which runs on a 54x24-inch split pulley placed 20 feet between centers. The steam pressure is 90 pounds per square inch and the engine speed is 100 revolutions per minute. A steam separator is attached to the steam line just above the engine cylinder.

Two three-wire generators are attached with double belts on pulleys having 10-foot centers. The machines are of 50 and 75 kilowatts capacity, each running at 430 revolutions per minute.

From each machine, generator cables are connected to a specially designed switchboard, from which power circuits at 220 volts and lighting circuits at 110 volts are carried in iron conduits to panel boxes placed on each floor of the building. From cutouts in these boxes power lines are carried to the rheostat panels which control the speed of the motors which are suspended from the ceilings of the various rooms.

Separate lighting circuits are provided

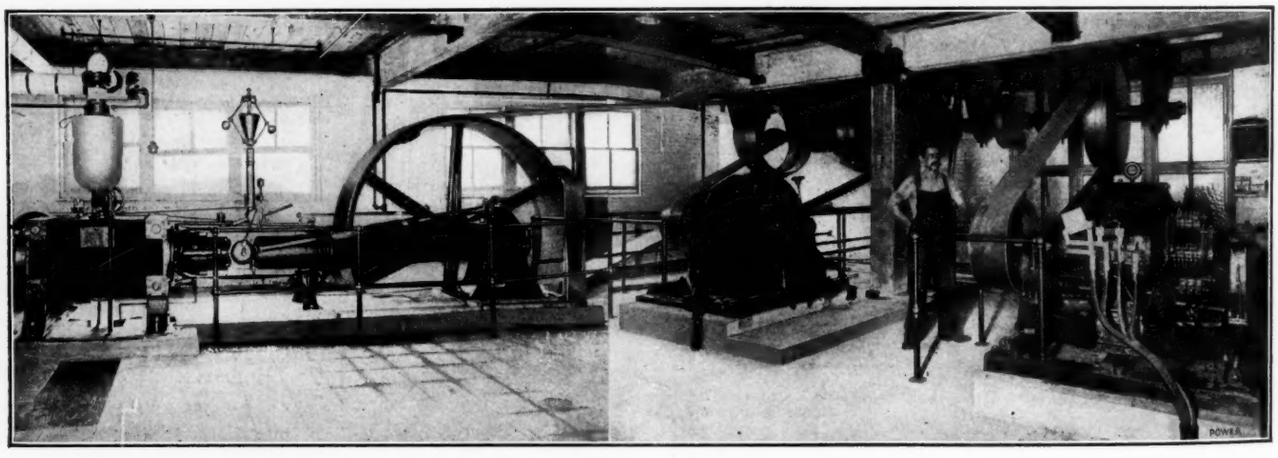


Fig. 1. Corliss Engine and Generating Equipment of Plant

for 100-watt tungsten lamps for the center illumination on each floor, for 16-candlepower lamps at each machine and for lighting the toilets, stairways, elevator, etc. The lighting circuits are all controlled from the panel boxes, to which access is had only by an authorized person. A separate power circuit for the elevator is carried in an iron conduit from the switchboard to the elevator shaft and through it up to the controller box on the roof.

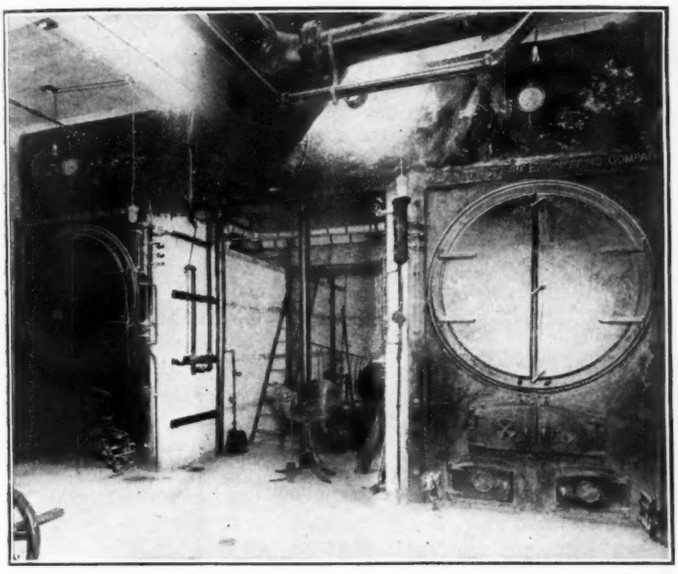


FIG. 2. THE BOILER ROOM

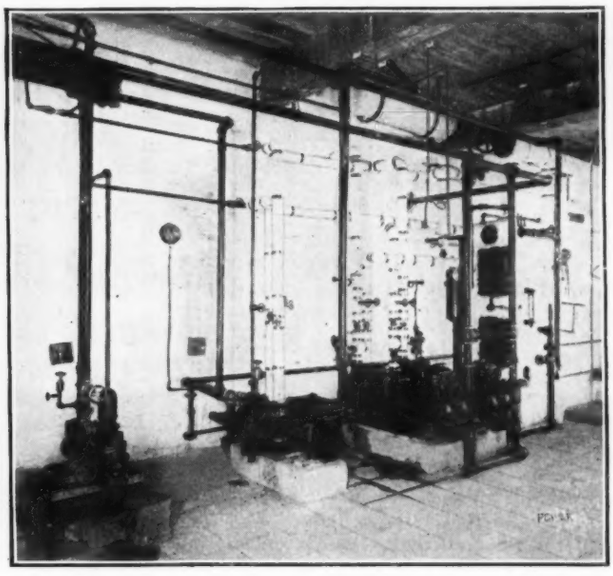


FIG. 3. PUMPING EQUIPMENT

SWITCHBOARD

The slate switchboard consists of three panels, one instrument panel for each generator, upon each of which are mounted two ammeters and a voltmeter, five-pole circuit breakers, ground detectors and pilot lights, and the distributing panel upon which are mounted separate five-pole switches for power and lighting circuits, also an elevator switch, and a separate switch for the basement lights.

All the machinery in the plant is motor driven except the heavy machinery in the basement, which is driven from a countershaft in the engine room. This shaft has a double-quill cutout, so that either generator can be thrown in or out at will.

AUXILIARIES

An open-type feed-water heater stands on a concrete foundation above the level of the engine-room floor. Connections are made by means of a three-way valve to the feed and exhaust lines. This heater combines a water purifier and oil separator and the water level is automatically machined by means of a ball float, and sustains a feed-water temperature of 208 to 212 degrees Fahrenheit.

PUMPS

There are two 6 and 4 by 6 duplex boiler-feed pumps controlled by a special Kitts pump governor; a separate steam pump for the house-service tank and a vacuum pump with an overhead receiving tank are installed on concrete foundations above the floor level. They are shown in Fig. 3.

The exhaust line from the engine is carried to the top of the building. A back-pressure valve is located at the ceiling and an exhaust head on the exhaust end above the roof. A live-steam line is carried to the top floor and is connected by a reducing valve to the exhaust line; it has connections on each floor for machine use. From the exhaust line on the top floor the heating mains are taken, being designed for a gravity and vacuum combined system of heating. The wall coils extend the entire length and breadth of each floor, and radiators are placed in the office and halls. The continuous wall radiators in all toilet rooms are connected with impulse and differential valves, insuring a uniform temperature of 70 degrees on each floor.

All drip lines from exhaust heads, machines and the heating system are carried down to the receiving tank and heater through the oil separator, and all high- and low-pressure returns are properly trapped.

A plan view of the power plant, showing the general arrangement of the machinery, is illustrated in Fig. 4.

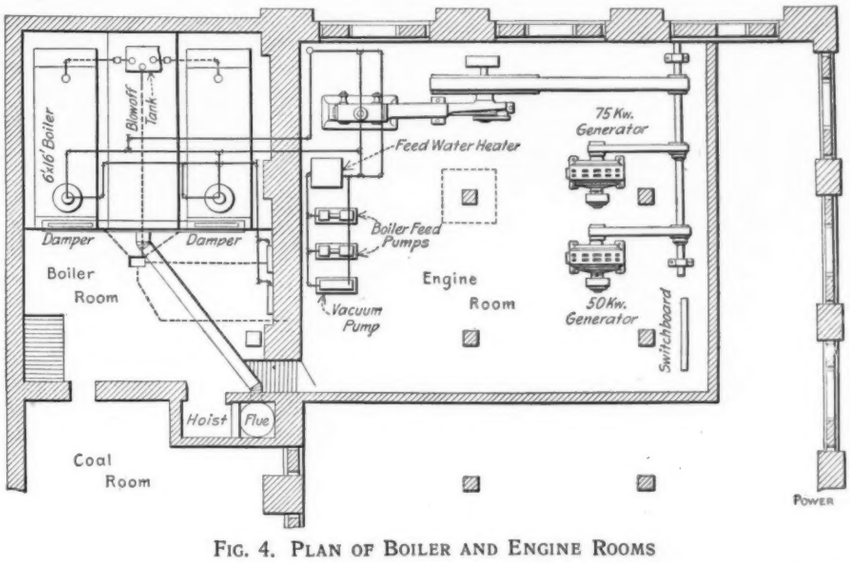


FIG. 4. PLAN OF BOILER AND ENGINE ROOMS

From cost records of the coal and water consumption used in developing power, together with the maintenance charges, an efficient showing has been made. The coal consumption averages 25 pounds of coal per day of 10 hours per operating horsepower, and the cost of electric current figures less than 3 cents per kilowatt-hour, a practical demonstration that manufacturing plants of this type can be operated more economically than if central-station service were used.

The power-plant equipment and electrical installation were planned and installed by the Wilkinson Steam Engineering Company.

Cost of Power in New England Mills*

By H. G. Brinckerhoff†

A careful record of all costs against the steam plant showed that power was generated for $16.68 per horsepower-year, which in this particular plant meant an annual saving of $10,000 over the price offered for electric power without making any allowance for the heating.

Early in 1907 the Fitchburg Yarn Company had to face the problem of either meeting the outlay of building a power plant of its own or purchasing electric power from outside. The best electric-power transmission offer was in the neighborhood of $30 per kilowatt delivered on the switchboard in the mill. The general manager, George P. Grant, Jr., believed he could do better than this, and he also recognized that some steam plant would be required anyway to do the heating and to supply the steam for conditioning yarn, etc., the investment for which by itself would be considerable, while in conjunction with a central operating plant for power it would be of slight account.

F. P. Sheldon & Sons, of Providence, R. I., consulting engineers, who had also designed a notably economical plant for the Warren Manufacturing Company, were therefore authorized to draw up plans and specifications for a suitable plant.

It was not until some time later in the spring of 1910 that a careful record of all costs against the steam plant was kept, and the following data are furnished by Raymond L. Foster, the chief engineer, who states that the average horsepower is taken every week from two sets of indicator cards for the period of a full year's run, ending March 25, 1911. The minimum diagram taken during the year showed 1291.83 indicated horsepower, and the maximum 2107.79 indicated horsepower.

POWER PLANT OF FITCHBURG YARN COMPANY FOR THE YEAR ENDING MARCH 25, 1911

Hewes & Phillips cross-compound Corliss engine, 26 and 56 by 60 inches:	
Boiler pressure per square inch	175 lb.
Receiver pressure per square inch	19 lb.
Hewes & Phillips independent driven venturi condenser.	
5 Dillon's Manning type boilers, 74-inch waist, 17-foot tubes:	
Grate area	192.40 sq.ft.
Heating surface	10,449 sq.ft.
Superheating surface	4,662 sq.ft.
I. B. Davis Gleaner exhaust heater:	
Water from	44° to 118°
I. B. Davis Gleaner heater:	
Exhaust of condensing engine and condensation from receiver, water from	118° to 152°
*Green Fuel Economizer, 4488 square feet heating surface:	
Water from	152° to 232°
Gases entering economizer	430°
Gases entering chimney	230°
Hight of chimney	165′
William A. Jepson coal, semi-bituminous:	
Cost of coal per ton	$4.50
Average indicated horsepower	1,744.28

COST OF POWER

4229.57 pounds coal per horsepower (including banking and heating)	$8.46	
Labor	2.92	
Supplies and repairs	1.11	
Total operating expenses		$12.49
Depreciation and interest	$4.01	
Taxes	0.72	
Insurance	0.04	
Total fixed charges		4.77
Total gross cost		$17.26
Deduct cost of heating		0.58
†Total cost one horsepower per year		$16.68

*Copyrighted, 1911, by the Green Fuel Economizer Company.

†New England manager, the Green Fuel Economizer Company.

It may be pointed out here that the inland location and altitude are against this plant for economical results compared with places like New Bedford, Fall River, Providence, Warren, R. I., and other seaboard towns which are favored with a cooler and more plentiful supply of injection water for condensing in summer, as these places, being at sea level, should give them the best vacuum, while the altitude at the plant in Fitchburg is about 480 feet, and the water for condensing runs as high as 108 degrees in summer. Nevertheless, in spite of such adverse conditions in the location, from the foregoing exhibit the saving secured in the adoption of a power plant of its own by the Fitchburg Yarn Company works out as follows:

One kilowatt at $30 is equivalent to $22.50 cost per horsepower.

$$\$22.50 - \$16.68 \times 1774.28 \text{ horsepower} = \$10,151.70$$

The above amount therefore is the saving on its cost for power over the offered price for electric power by other parties. Even on the gross cost at $17.26 it would show $9140.02 saving per year over buying power, and besides getting all heating.

In the above calculation of difference of cost no reckoning is attempted to include the cost for the electrical power which would have been paid from the switchboard record for all the electrical losses in the motors and wiring beyond that point, which the mill would have had to stand, and which Mr. Sheldon estimates would have increased the amount to be paid for such electrical power by at least 12 per cent., although 18 per cent. is nearer the results obtained in practice.

To make the situation truly comparative to the case of purchasing outside electric power, the expense for building and maintaining a special heating plant would further augment the advantage of saving shown by the central power plant. Mr. Sheldon writes in regard to this:

"I should estimate the cost for the necessary boilers, piping, covering, building, pumps, chimneys, etc., for a steam-heating plant only to be about $9000, employing the same method of heating as now, and the cost of doing the heating, if the same method is used as now, ought to be the same as it is now. I can see no reason why it should not be the same, and on the $9000 item I should estimate for interest and depreciation, 10 per cent."

It is obvious that the labor costs of a heating plant only would be greater than when had in connection with a central plant, which would make such data a matter of judgment to dissect from its inclusive cost in the above. Therefore, on some closer basis of offering for electrical power any interested party could as competently calculate more exactly the comparative cost of the independent-power advantage to a closer and more profitable basis. The writer does not believe that anything would be gained to further work these data out here, as the exhibit is comprehensive as shown. The object of the paper is to develop the normal cost for factory steam power for its complete operation, and not an attack on electrical transmission.

It is worth noting that there are no "frills" to the equipment. The engines, boilers, heaters and economizers are standard designed goods, such as are found in the usual run of modern mills, and hence the result may be accepted as a fair showing of what any similarly equipped mill might readily equal.

No attempt was made to scrimp on supplies, inferior labor or care, to make a fancy showing. Everything necessary in these respects to assure reliability of operation within the limits of ordinary prudence and wise economy is the policy of the management, and can be comprehended by the fact that the mill has suffered no losses from shutdowns of the power plant, operating continuously 56 hours a week, except for six holidays.

Quite probably the repair item may grow somewhat larger outside of renewals that may be properly charged to depreciation. But even so, allowing 60 cents per horsepower additional, which

*The size of the Green fuel economizer has since been increased.

†Corrected to the standard basis of coal at $4 per ton, the cost would be $15.74, or $0.0055 per horsepower-hour, equivalent to $0.0073 per kilowatt-hour. The Warren Manufacturing Company, which is a larger plant on the same basis and adjusted to the same number of hours per year, showed a cost of $14.57 per horsepower, or $0.0051 per horsepower-hour, equivalent to $0.0068 per kilowatt-hour.

with the depreciation ought to maintain the plant in top-notch condition, brings the cost up to only $17.28.

As a more probable happening, with the development of the business, and it is growing very rapidly, the costs will tend to fall markedly, and were another 500 to 600 horsepower added, the plant would easily show as low as $15 per horsepower actual total yearly cost.

It may be noticed that the final temperature leaving the auxiliary is 152 degrees. This was the result of Sheldon & Sons' intention, by installing power-driven pumps and an economical type of Corliss valve condenser, to keep down the steam consumption and not to manufacture an expensive byproduct of exhaust steam that could be only partially regained in the feed water, recognizing that a proper source for heating the feed water exists in the recovery of heat going up chimney. Just as the Gleaner heaters are accomplishing all they can do and were expected to do, so the Green economizer is seen to be doing likewise, with a low flue-gas temperature entering at only 430 degrees. Although the showing on the heaters and economizer is considerably reduced in the exhibit for the year's average, caused by fluctuations of over 800 horsepower in operating, making conditions for their proper showing below normal for their ability, yet for neither class of feed-water heaters were excessive wastes manufactured for the benefit of having these heaters make a superior showing. The general layout shows a simple, well designed plant, purposed to avoid all sources of waste. Its economy is remarkably good for a plant not exceeding 2000 horsepower in capacity.

Davies' Experience, a Tragedy

By R. O. Richards

While drawing the fires, because of sudden low water, Davies, the fireman, is struck down by his drink-crazed chief. He falls among the white-hot coals and is fearfully burned.

There's a moral.

A short while before Davies succumbed to the dreaded derangement of mind which now closely confines him to an asylum, he recounted to me the incidents of the tragedy in which he incurred the terrible scars that so completely disfigured his face and hands. I was the more surprised at the recital as, hitherto, he had been most reticent concerning what we, his friends, had always believed to be the result of an accident. We had never questioned him for we respected his evident desire not to speak of it, and we carefully refrained from adding to that sorrow which we knew to be burdening his mind.

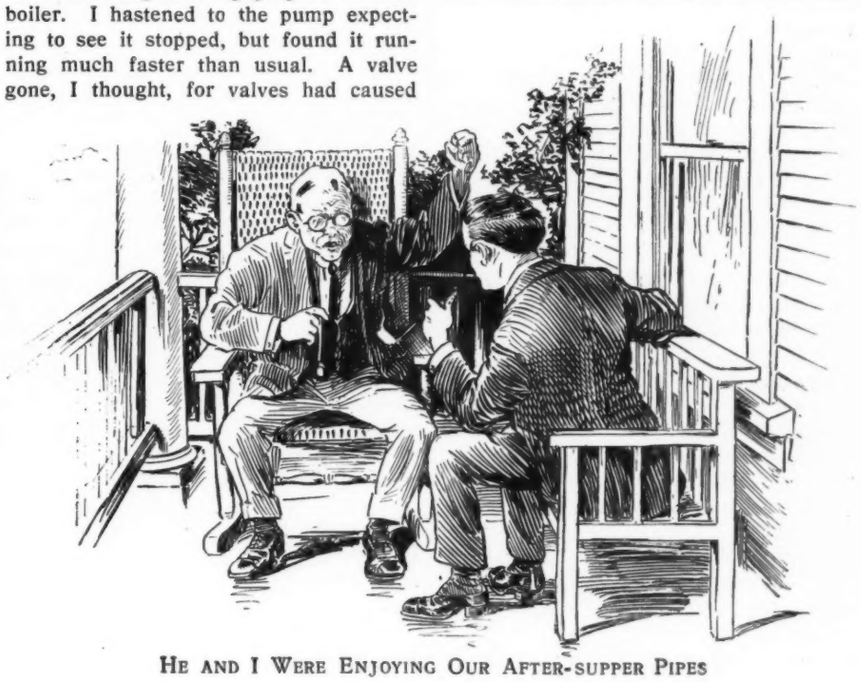
It was upon a Sunday evening, when he and I were enjoying our after-supper pipes, seated in comfortable chairs on the veranda, that he related the incidents of the occurrence.

"Twenty years ago, I was a fireman in one of the many engine houses dotting the slate quarries of a town in north Wales. I had two boilers to operate, but the old engine demanded but little steam and my position was pleasant enough. I had bright prospects of succeeding my old chief and then having and enjoying a home of my own. But before these ambitions were realized our native quarry manager was superseded by an Englishman who believed in nothing that was not English. I, therefore, was not surprised when a burly six-foot Englishman took charge of our engine house on the retirement of the chief. What part of England this man came from I was never able to discover and it is well that I did not, as later events will show. His preceding job must have been close to a tavern for, surely, no man in his leisure hours only could learn to dispose of the quantity of intoxicants to which the empty bottles bore daily witness. He left to me the whole care of the station and as long as nothing untoward happened I felt no alarm for the plant; I had the time to do his small share of the work as well as my own.

"But—" and here Davies took off and wiped the colored spectacles which he wore—"but it is the unexpected that will happen some day in every plant, and happen it did in ours. It was about two o'clock one afternoon when I noticed the water lowering in the gage glass of each boiler. I hastened to the pump expecting to see it stopped, but found it running much faster than usual. A valve gone, I thought, for valves had caused the only trouble I had ever experienced with this pump. Expecting to obtain sufficient water in the boilers to effect a hurried repair, I speeded up the pump. We had another, but it was out of commission for want of plunger packing, requisition for which had been in the hands of the chief a month previously.

"After half an hour, during which time I had tried every expedient at my command to increase the volume of water in the boilers, I commenced to feel real alarm, for instead of rising the water was steadily lowering so that now it stood within half an inch of disappearing.

"Clearly something had to be done, and that quickly, but why should I take the responsibility of shutting down the plant? Was not the chief there for that purpose? Drunk or not drunk, I would compel him to shut down the engine, even if I had to prop him up by the throttle. But a glance at the sodden figure huddled in the engine-room chair convinced me that no aid could be expected from him.



HE AND I WERE ENJOYING OUR AFTER-SUPPER PIPES

Had I time to replace that defective valve before that half inch of water disappeared in those glasses? Surely, the worst that could happen is a shutdown,

which seemed inevitable, unless I risked the repair. Without wasting another moment, after quickly starting the idle pump which I hoped would throw some water if allowed to race, I commenced tugging desperately at the nuts on the valve chest of the other. Oh, why had I drawn them up so tightly? Surely that old piece of canvas which I had white-leaded and used for a gasket in lieu of something better did not require the nuts to be drawn up so tightly as this. A stud broken! I hope I do not break any more. Such were my comments as I labored to clear that valve-chest cover only to find when it was removed that both sets of valves were intact. Clearly then it must be the plunger packing and there was not an inch anywhere in the plant!

"I arose from my stooping posture with a bitter smile, and clenching my fist I shook it in the direction of that English manager's office. 'Now,' I exclaimed,' 'what do you think of your d—— Sassenach, drowned in your English ale. You ——,' but the necessity of quick action withheld me.

"The old pump clattering in the corner had done well, for there was a quarter inch of water still visible in each glass. It was apparent, however, that the engine must be stopped immediately and the fires hauled out.

"Determined that the chief should take the responsibility of shutting down the engine, I proceeded to the engine room and, knowing that verbal persuasion would prove ineffective, I vigorously shook him—shook him until his teeth rattled, for now my Celtic blood was aroused. Hauling him to his feet, and alternately pushing and pulling, I stood him up in front of the throttle and bade him close it. But there he must have collapsed, for when I returned to the engine room after drawing out the fire under one boiler, I found him huddled in a heap on the floor. Hastily picking up a bucket I filled it with cold water and doused him with the contents. He blinked, coughed and spat, but finally he sat up with a gleam of understanding of what I was profanely bellowing at him. Satisfied that he understood, I returned to the boiler room and commenced hauling the fire from under the other boiler.

"As I bent to the work I was annoyed by water dripping from the roof. At first I took no notice of it, but the persistence with which it dropped on my bare head caused me to stop and look through the open window, curious to know if it was raining. 'It is not raining; where is that water coming from?' I questioned. Like a flash the cause of the leakage almost overwhelmed me. Calling myself all the fools' names that my own and the English language contained, I ran for the engine room. The chief was standing by the throttle, unsteadily closing it. Excitedly I swept him aside, and with strong sweeps opened it again, while I yelled, 'The heater, the heater!' I pushed him aside quite roughly and he lay sprawled on the floor. Stooping down beside him with slow emphasis, that each word might pierce the thick fog of his befuddled understanding, I cried, 'Don't stop the engine; you have a split tube in the heater!' And I pointed to the huge upright affair that stood on the same level as the engine, but towered five feet above the cylinder.

"Not wishing to take any chances with him, however, I hurried back to the boiler room, opened the heater drip and stopped the pump. There now remained but to pull out the rest of the fire and explain matters to the irate manager when he appeared. I had about accomplished the hot work of drawing out the fires, when the light from our only window became partially obscured by a shadow. Before I could look up, I received a blow on the head with some object—an empty bottle they afterward told me. Stunned, I pitched head first and face downward into the midst of that ton of white-hot coal, that had almost baked me even to draw it out.

"My God! the memory of it even now unmans me!" and Davies again took off those ugly spectacles, but, now, it was to wipe away the tears which suddenly welled at the poignant recollection of his awful experience.

"Say no more about it, Davies," said I; "let it go at that," for I was becoming affected myself.

"There is not much more to tell," he continued. "When I came to at the hospital I related the incidents to some of my friends, who had anxiously gathered around my cot. Early next morning, it is said, a dozen picked men—men from whom the wild and the reckless had been eliminated—a dozen jurymen capable of strict justice, but jurymen also determined to personally execute their verdict, lined the narrow pathway leading to the engine house. But they waited in vain for the culprit; during the night he had vanished.

"When I got well I thankfully received the money which my fellow-workmen so kindly collected for me, and with it purchased a passage for this country. I was offered the position of chief at the old place, but I crossed over here to avoid embarrassing the woman I loved, and to escape that awful passion which would drive me to hunt that man and kill him."

The fund left by the late George M. Pullman for a free school of manual training at Pullman, Ill., has recently been increased to over $2,500,000. A site has been purchased, and Prof. L. G. Weld, the dean of the school, is visiting schools throughout this country and Europe in preparation for the definite planning of the new school.

First Western Built Automatic Engine

"So far as I have been able to learn," said Orosco C. Woolson, of New York City, to a POWER representative recently, "I believe I am entitled to the distinction of having erected and run the first Western-built automatic cutoff engine ever set up west of the Alleghany mountains."

Believing that its description and early history would be of interest to POWER readers, the interviewer induced Mr. Woolson to talk of his pioneer labors in automatic steam-engine work. He said:

"The engine was built in Ohio and set up in Chicago in 1871-2. In these days it would not be considered a very big engine, yet at that time it was larger than most horizontal semi-high-speed engines found in the country milling districts. I understand that they started building the Buckeye engine about this time, and I saw what was said to be the first on the cars after I had set up the Chicago engine.

"I do not now remember the exact dimensions of the cylinder of this Chicago engine but it was rated at 200 horsepower. The bed was of the Porter-Allen pattern, with an overhang cylinder supported at its outer end upon a cast-iron pedestal, but not bolted thereto. The automatic valve gear was built from the patents of two of the finest men this country has ever produced.

BABCOCK & WILCOX VALVE GEAR

"Doubtless there are many who do not recall this valve gear of Messrs. Babcock and Wilcox, and many of the present generation who are ignorant that there ever was such a valve gear. The name Babcock & Wilcox has been so intimately associated with steam boilers the past forty-odd years that it may seem to them that it was always boilers. There was a time, however, when Mr. Babcock and his partner were devoting much time and money to their engine, which promised to become a potent factor in steam-power equipment.

"Some may recall the effort made by these gentlemen, back in the sixties, at the old American Institute on Third avenue, in this city, to exhibit the working of their cutoff mechanism within the steam chest. They substituted for the large cast-iron steam-chest cover a cast-iron frame with heavy clear-glass panels.

This was more successful in standing the pressure than might be supposed, but great care was necessary in bolting up as well as in heating up. So far, however, as affording a view of the interior working parts of the cutoff was concerned, it was practically a failure, due to almost continual condensation; and it was only at intervals that any moving part could be seen in motion. The cracking of the glass panels finally com-

pelled their removal and replacing the original cover.

"I do not know of any engines now being built with a similar cutoff. To describe its character is simple enough, but to understand it without drawings may not be as simple to understand. One feature of the design of this Babcock & Wilcox engine was the large steam chest, extending the whole length of the cylinder and nearly as wide as the diameter of the cylinder. Within this chest was a large box valve, on the back of which were located two cutoff riders, placed one at each end, as nearly over the main steam ports as was possible, to reduce the clearance to a minimum. Midway between these riders or cutoff plates, upon the box valve, a small steam cylinder was located with its double-ended piston rod extending each way to the cutoff plates. To the rear cutoff plate was connected another rod extending out through a stuffing box at the outer end of the steam chest.

"This telltale rod, of ½-inch steel, was the only tangible connection between the inside mechanism and the outside world except the oscillating rod which actuated the cutoff-cylinder valve. As this oscillator was controlled by the engine governor it timed the throw of the cutoff plates. This mechanism and its connections were very ingenious, and if the efforts of Messrs. Babcock and Wilcox had succeeded in making the working mechanism show through the glass steam-chest cover, it would have created great interest and enthusiasm.

"The engine gave an excellent diagram when working normally. While it was a simple matter to screw up the stuffing-box gland too tight at the telltale rod at the rear or try to start off with the tallow in the packing a little too cold (thus freezing this rod and preventing the cutoff plates throwing at all, or at other times sluggishly), still, after this idiosyncrasy was made plain, but little trouble was experienced.

"No, I did not continue in engine work. I have given more attention and study the past 20 years to combustion and special furnace work as being of more importance, possibly from the same reasoning that Messrs. Babcock and Wilcox abandoned engine for boiler construction. To them the boiler was of greater importance.

"When it comes to these two problems of the boiler and the furnace, the boiler must wait on the furnace; a furnace can be run forever without a boiler, but a boiler cannot be run for an instant without a furnace. From my way of reasoning, the furnace has the big end of the whip, but it makes a vast difference what is the character of that whip."

Is Peat an Important Fuel in the U.S.?*

By Charles A. Davis

It is estimated that there are 11,200 *square miles of peat beds in this country, containing* 13 *billion tons of salable coal.*

The best peats run as high as 11,000 *B.t.u per pound.*

Most failures are attributed to the inexperience or ignorance of those having peat development in charge.

*Abstract of paper read at a meeting of the New York section of the American Chemical Society, by permission of the Director of the Burau of Mines.

If the question is asked for the entire country and for the immediate present, only a negative answer can be given by even the most optimistic.

On the other hand, one has but to glance at a map showing the distribution of the regions of abundant workable peat deposits in the United States to see that they lie almost entirely outside of the coalfields of the country. Moreover, they are found in districts where much fuel is required and where fuel of every kind is constantly growing more costly as economic conditions change, demands on the diminishing supplies of wood, coal and other fuel supplies become more insistent, and transportation and handling charges become higher.

The total area of peat beds in this region which have sufficient size, depth and purity to be attractive for commercial exploitation, has been conservatively estimated at approximately 11,200 square miles; these beds, in round numbers, contain at least 13 billion tons of salable fuel. There is probably an equal or greater area of small peat deposits, with, at the least estimate, an equal possible tonnage, which could be worked for fuel by individuals or small communities but might not be attractive for larger investors.

This estimated tonnage would supply the entire country with fuel for many years if used at a rate equivalent to the present rate of coal production. If used only in the parts of the country where it occurs, it is obvious that the useful life of the resources would be much prolonged, as well as that of the fuels which would be displaced.

When properly prepared and used in correctly designed fireboxes, peat is a fairly good fuel, the best grades, on the theoretically dry basis, exceeding in thermal value many lignites and some of the poorer grades of coal. The best peats may run as high as 11,000 B.t.u. per pound, but those giving from 8000 to 9000 B.t.u. are much more common, just as medium-grade coals are more common than those of highest calorific value.

Not on a Commercial Basis

Although peat has been used as domestic fuel in Europe for many years, and there has been a marked increase in its use for power production in Sweden, Russia and Germany during the past decade, it has never been produced on what could be termed a commercial basis in the United States. For this reason it has frequently been said by American writers that other and better types of fuel were so abundant and cheap in this country that there was no place for peat, when, as a matter of fact, in at least some of those parts of the United States where peat is of frequent occurrence, coal sells at considerably higher prices than good English coal can be had in some of the peat-consuming countries of Europe.

Such writers also point out that, in spite of the large sums of money spent in establishing peat-fuel factories in the United States, no peat fuel has been put on the market, and therefore they say that peat fuel is a failure here. As a matter of fact, however, a careful analysis of the attempted manufacture of peat fuel in the United States shows that other causes than qualities inherent in the peat have been operative to prevent the success of the factories mentioned, and that every pound of the fuel which they have made could have been or has been sold; in fact, much more has been called for than could be delivered. The causes of failure have been such as beset all new and untried industries, and most of them could be directly traced to the inexperience, the optimism and, too often, to the ignorance of those having the developments in charge. The experience of European experimenters and manufacturers has been passed lightly by as not applicable to our conditions or often has been entirely ignored, and untried machines and processes substituted for those of proved worth. Not infrequently purely visionary plans and machinery, based on entirely wrong conceptions of the properties of peat, have been made the basis of the enthusiastic promotion and construction

of costly plants which from their inception never had a chance to successfully produce peat fuel on a commercial scale.

Its High Water Content

The greatest practical difficulty in preparing peat for fuel lies in its high water content, which may exceed 90 per cent., as it lies in the bog, and rarely, even in drained bogs, is lower than 80 per cent. After trying and abandoning many devices for pressing the water from peat, for treating it by heat, both directly and by superheated steam and by electricity, to remove the excess of water, European peat-fuel producers have now come to rely almost wholly upon the sun's heat for drying their product. The raw peat, wet as it comes from the bog, is thoroughly pulped or ground in simple machines and either formed into bricks which are removed from the machine and laid out to dry on pallets or, by the most recent practice, the macerated, wet peat is spread by the use of a simple spreading device into a thin sheet on the roughly prepared surface of the bog, as near as possible to the excavating pits. The same machine which spreads the pulp also cuts it up into brick-shaped pieces, which, when dry enough, are turned and still later are piled up in small open heaps, and, when they have dried sufficiently, they are stacked under sheds or in loosely piled stacks to complete the drying process.

It has generally been assumed by American experimenters that such a method of procedure was not adapted to labor conditions existing in the United States; hence no serious attempt has been made in the country to establish a peat-fuel factory of this kind to learn if it could be made profitable here. In Canada, however, the Mines Branch of the Dominion Department of Mines, after careful preliminary investigation, established in 1909 a peat-fuel plant for demonstration purposes. It was equipped with machinery that had been thoroughly tested by continued commercial success, imported from Sweden, and the entire operation of the plant was placed in charge of a well trained and experienced man. The work at this factory was carried on by laborers hired in the neighborhood of the plant, who were paid about the same wages that would be had in the United States for similar work. The capacity of the plant was rated at 30 tons per day of salable product. The output for the first short season's run was given as 1600 tons and the average cost of production based on this and all charges included, according to official figures, was $1.65 per ton loaded on the cars, of which only about $1 was for actual production. This price, it is stated, could be reduced by the use of mechanical diggers, already perfected, in place of hand digging, which was used.

Calorific Value

Peat fuel made by this method has a calorific value considerably greater than half that of good bituminous coal and is a more acceptable fuel than coal to many people for cooking and other domestic purposes; in properly constructed fireboxes it is excellent for steam production. It was estimated by the Canadian authorities that the equivalent of a ton of anthracite costing in Ottawa $7.50 could be made ready for use for less than $3.

As to the possible use of peat fuel of this type for power generation, it is an old story that several industries, notably cotton factories, in Russia for years have been using peat fuel for generating steam; it is also reported that this use increases at the rate of about 200,000 tons a year. In Germany and Sweden also there is a growing use of this fuel for power production, kiln firing and foundry work.

A Good Fuel for Gas Production

The most recent advances in utilizing peat for fuel, however, have been made by its use in the gas producer for generating power and fuel gas. It has been established beyond question by experiments by the United States Geological Survey, by the Canadian Department of Mines and by successful commercially operated plants in Sweden, Germany and other countries of Europe that air-dried peat is a good fuel for gas production. In some makes of producers designed for the purpose, peat is now gasified and made to furnish a clean and uniform gas of good calorific value to gas engines, and lighting and power plants are known in which no other fuel than peat has been used for several years past.

A recent report of one investigator, who has had exceptional opportunities for working on the subject, states that with the type of gas producer with which he has worked he gets a producer gas which enters the engine entirely free from tar and other bituminous matter, and that the producer required no poking or other attention except when fuel is added and the ash removed, so that one man can attend to both the producer and engine. The average result of test runs with this producer was a horsepower per hour for somewhat less than 2 pounds of dry peat fired, which is in close accord with results obtained elsewhere. The author of this report also says that he feels justified in stating that if peat fuel can be delivered at the producer for $2 per ton, the cost of a horsepower per year, in plants equipped with gas producers and using peat fuel, should be about $7.50.

As $2 per ton is a very conservative estimate for the production and delivery of air-dried peat, especially if the power plant is located near the bog, it is more than probable that the figure given may be diminished rather than increased in the near future.

Recovery of Useful Compounds

The commercial recovery of useful chemical compounds from the products of the gasification of fuels has been so successful that it is not remarkable when it was found that carbonized peat was in demand—but could not be made at a profit unless the gaseous products of the distillation were utilized, as they were already in the making of wood charcoal—that practically the same processes of recovery and purification should be used in making peat coke as for wood carbonization, and about the same series of compounds obtained.

Furthermore, when it was found that in many peats the percentage of combined nitrogen exceeded that of other fuels, the matter of recovering this indispensable substance was taken up in earnest and made the subject of thorough study, especially along the lines worked out by Mond, in connection with the generation of producer gas from coal. Announcements have been made within the past year that this matter has been worked out so satisfactorily that three large electric-power plants in different European countries are now being successfully operated by gas producers, using peat as fuel, and recovering from the producer-gas ammonia in the form of sulphate in quantities sufficient to make the entire operation very profitable; other plants of the same or similar types are in process of development and it is not improbable that there may soon be one or more of these plants in the United States. These announcements are of greater interest to all concerned in peat utilization, because they positively state that peat containing 60 or even 70 per cent. of moisture can be utilized in the gas producers and give a satisfactory quality of producer gas. The ordinary type of double-zone gas producer for bituminous fuels may be run on peat having as much as 40 or even 45 per cent. of moisture, but the consensus of opinion seems to be that better results are had when the moisture content is below 35 per cent. and the difference between this and the figures cited above is larger than appears at first glance; peat can be dried quickly to 65 per cent. moisture where it might be weeks in reaching the air-dried state.

Considering further the use of peat as a source of producer gas, careful comparison of the thermal value of the gas derived from it, as compared with coal, based on rather meager data, shows that the peat gas has about the same, or a slightly larger, number of thermal units per cubic foot as gas generated from coal in the same type of producer, while

in case of handling, quality of the ash, clinkering, etc., peat has the advantage. To secure the highest efficiency in scrubbing as well as in gasification, the producer in which peat is to be used should be specially designed for it, but the same is equally true of other fuels.

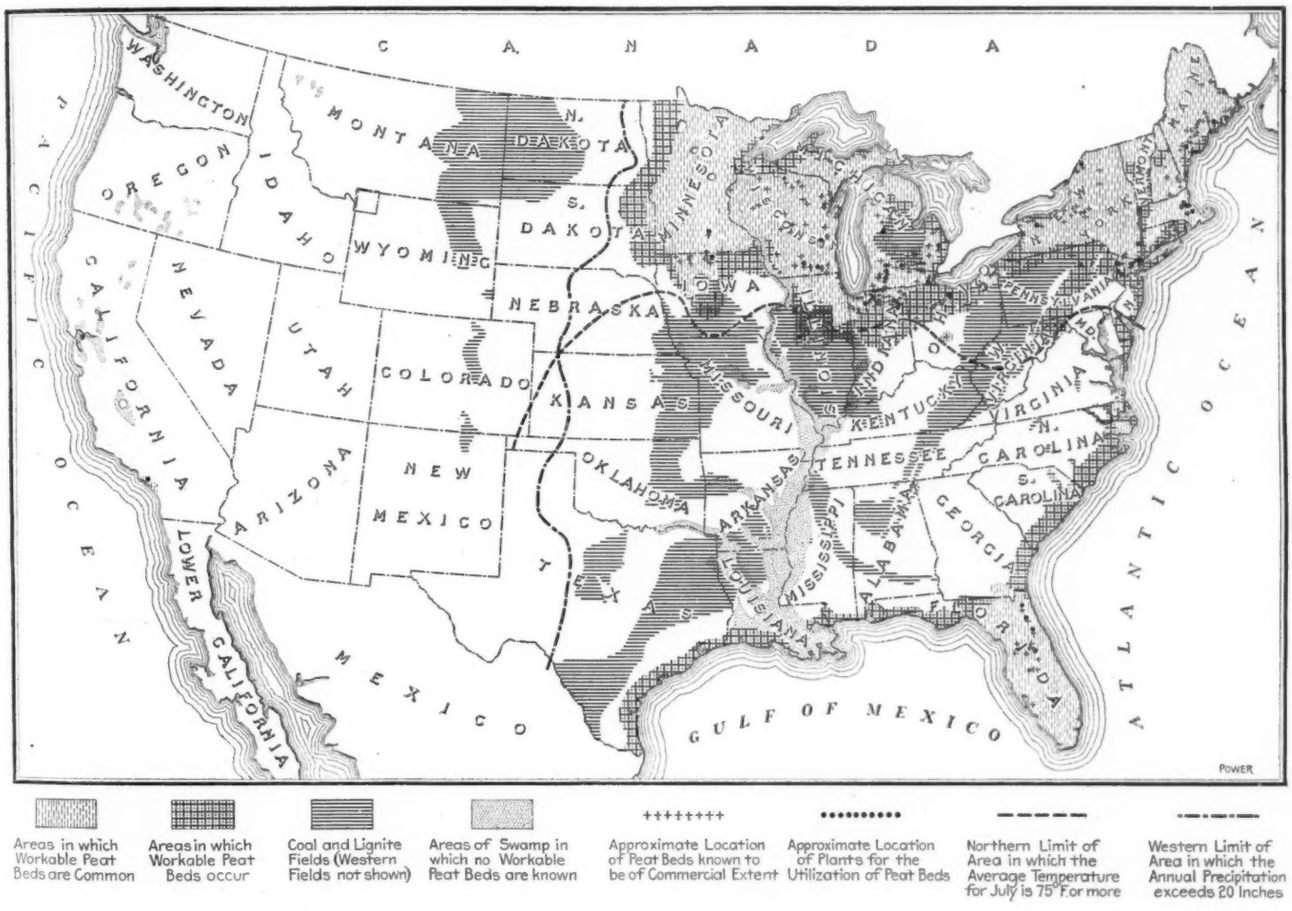
Peat in the form of finely ground dried powder has been used as fuel in Canada and in Sweden, and carefully conducted tests have been made in the latter country, both under government engineers and by testing commissions appointed by manufacturers' associations.

The reports of these tests agree that good peat prepared and burned in this way was very nearly as efficient, ton for ton, as the English coal with which it was compared, 1.2 tons of the peat equaling in steam-raising efficiency a ton of coal, the cost of the peat being 17 per cent. less ($2.76 + 50 cents instead of $3.95, the cost of coal) than that of the coal required to do the same work.

In this country efforts have been made to eliminate the use of hand labor in preparing peat for use in the gas producer or for boiler firing, and these seem now about to be crowned with success. If they are, and if peat fuel can be delivered to gas producers of boiler plants located on or near peat deposits—as has already been done in several places in Europe—at figures that seem quite within reasonable possibilities, in the opinion of the writer, peat is certain to be a fuel to be considered of importance to the parts of the United States where it is found, and indirectly to the whole country.

Discussion

In introducing his paper, Mr. Davis spoke of a case of which he knew where a bed of good peat 12 feet in thickness is being removed in order to get at another product and coal is being brought from a distance of 1000 miles to conduct the operation while the peat is thrown away. In another place a bed of excellent peat 20 feet in thickness is being covered up by the slag and ashes from a coal-operated plant. He mentions also another case where expensive coal was being used in the process of digging up good peat and throwing it away. In reply to a question if there were considerable peat deposits around New York City, the lecturer replied that there were none unless they were to be found in the extensive salt meadows. An inquiry in regard to the amount of ash brought out the reply that good peat should contain not over 10 per cent. and it is often found with less than 5. In Europe it is considered of commercial value if it does not run over 20. In one case peat containing 35 per cent. of ash was used in a gas producer and generated an electrical horsepower with a consumption of 4 pounds, which was not bad in view of the fact that in addition to the 30 per cent. of ash it contained 15 per cent. of moisture. In reply to an inquiry as to whether centrifugal separators have been used for the extraction of the moisture, Mr. Davis replied that attempts had been made in this direction by the German and Swedish governments but had not been successful. It is possible to get about 70 per cent. of the moisture out in this way or by pressing, but unless the peat is divided into a very thin sheet under very considerable pressure it is difficult to dry it beyond this point by either of these processes. A block of dried peat is about as tough and hard as a block of wood. The drying process appears to develop the colloids which act as a binder. Peat can be air dried in the United States down to from 10 to 20 per cent. according to location. In the vicinity of New York, 20 per cent. would be about the average.



Over 1½ million acres of public land now stand withdrawn by the Government as being valuable for the possible development of water power. During October the United States Geological Survey recommended the withdrawal of 54,422 acres as having power possibilities.

Smoke Abatement in Great Britain

By John B. C. Kershaw

Report of the smoke-abatement conference and exhibition held at Manchester, Nov. 10 to 25. Many papers were delivered by prominent engineers setting forth their views as to the best methods of smoke prevention, and statistics were given showing the harmful effects of a smoke-laden atmosphere.

The latest method of attacking the smoke problem in England is by arranging for exhibitions of smoke-abatement appliances in the larger towns and manufacturing centers, together with conferences of delegates from associations (both municipal and voluntary) whose express purpose is securing some diminution of the smoke nuisance.

This method of attacking the evils resulting from black smoke has much to recommend it. Doubtless, much of the smoke produced in large towns is due to ignorance on the part of the general public and the factory owners. It is now certain that smoke is preventable, and with the most uptodate boiler and furnace appliances, and with skilled management smokeless combustion may be secured in nearly all manufacturing plants without sacrifice of economy. Any method of education which helps to extend the knowledge of the scientific principles upon which smoke abatement is based and of the apparatus and devices by which these principles can be applied in practice, is therefore of great value in combating the smoke nuisance.

The exhibition held about a year ago at Glasgow was most successful, with an average attendance of over 4000 persons per day. This fall, Manchester followed the example of Glasgow, and a very successful exhibition was held in the City exhibition hall from Nov. 10 to 25, while a largely attended conference of delegates from various societies was held on Nov. 21 and 22, in the Manchester town hall. An account of the addresses and papers read at the conference and of the exhibits has more than local interest.

Gordon Harvey, as president of the Smoke Abatement League of Great Britain, delivered an address in which he stated that smoke from factory chimneys could be entirely stopped if the three following conditions were fulfilled:

1. Adequate boiler power.
2. Proper appliances for stoking and for regulating the draft.
3. Careful and constant supervision of the boiler plant by competent men.

Doctor Des Voeux, the representative of the London Coal Smoke Abatement Society, followed with a brief paper giving some startling facts and figures relative to the losses due to smoke. Exact measurements prove that London's loss of sunshine varies from 15 per cent. in summer to 50 per cent. in winter, and it has been estimated that the canopy of smoke which hangs over the metropolis costs that city £5,000,000 (about $25,000,000) per annum.

As regards the influence of black fog on the death rate, Doctor Des Voeux stated that in the autumn of 1909 Glasgow was visited by two periods of smoke fog, each lasting several days, but separated by an interval of a few weeks. During the first period the death rate suddenly rose from 18 per thousand to 25 per thousand, and during the second to 33 per thousand, although the rate in the surrounding country was hardly raised. It was calculated that 1063 deaths were attributable to the noxious condition of the atmosphere.

The physical evils and destructive effects of smoke were further emphasized by Professor Cohen and by Mr. Ruston. The former, in an illustrated lecture upon "The Effects of Coal Smoke," gave details of the results of numerous observations carried out at Leeds and the surrounding district relative to the composition of soot, the amount of soot emitted from chimneys and to the acidity of the soot suspended in the air. His remarks were as follows:

The first accurate experiments on the quality of suspended carbon or organic matter in the air were made by the late Doctor Russell on London air, and the results showed the following quantities for fine, dull and foggy weather in milligrams, per 100 cubic feet:

Fine weather	0.35
Dull weather	1.03
Foggy weather	2.44

Experiments carried out in Leeds agree very closely with these observations, being on the average 1.2 milligrams per 100 cubic feet. Supposing the soot to be uniformly distributed to a height of 300 feet before being dispersed, according to Dr. Angus Smith's estimate, and further, that the atmosphere is renewed 50 times in 12 hours, a simple calculation shows that five tons to the square mile is daily discharged into the air of Leeds, and that 200 pounds is suspended at any moment over one square mile.

This has been estimated by collecting snow on consecutive days during clear weather, and also rain water. From the latter the amount of suspended matter, including carbon, tar and ash, in tons per square mile per annum, was determined at different stations, and the results are given in the accompanying table. The character of the station is indicated.

The average for the whole town area is approximately 220 tons per annum per square mile, and this represents wasted fuel.

Mr. Ruston's paper, "Effects of Smoke on Vegetation," was in the nature of an appendix to Professor Cohen's remarks, and dealt specifically with this aspect of the subject. He thus summarized the deductions from his experimental observations:

1. It is possible to get a measure of the effective damage to vegetation by smoke pollution.
2. The factors in smoke pollution which prejudicially affect vegetation are:
   a. The smoke cloud limiting the available sunlight.
   b. The tarry matter coating the leaves and choking the stomatic cells.
   c. The presence of free acids in the air, tending generally to lower the vitality of the plant.
   d. The effect of the free acids falling upon the soil and limiting the activity of the soil organisms, principally the nutrifying organisms.

The last factor can be dealt with very effectively by a simple application of lime, while the first two can be met only by checking the output of smoke, and using every effort to lessen the air pollution, which is the ruin of many crops.

SOLID IMPURITIES IN RAIN WATER (TONS PER SQUARE MILE PER ANNUM)

Station	Suspended Matter			
	Carbon	Tar	Ash	Total
Industrial:				
Leeds Forge	189.6	31.4	318.0	539
Hunslet	241.2	19.7	187.2	448
Beeston Hill	87.1	42.6	202.5	332
Philosophical Hall	99.7	22.3	120.6	242
Residential:				
Headingly	100.2	12.3	56.9	188
Armley	98.0	9.7	61.7	169
Woodhouse Moor	63.2	9.1	41.7	114
Kirkstall	52.3	8.0	40.3	100
Weetwood Lane	19.2	7.4	15.4	42
Roundhay	7.7	4.0	14.0	25

Two very practical papers upon steam-boiler management were read by G. B. Storie and James Bibby. Mr. Storie's paper was a résumé of the now generally accepted scientific principles of smokeless combustion in steam-boiler furnaces, and while containing nothing new was of interest as coming from an engineer in charge of a large steam plant. Although a firm believer in the advantages offered by artificial draft, he is not a supporter of the steam-jet system for obtaining this, as the following extract from his paper shows:

Artificial draft is independent of atmos-

pheric conditions and may be produced by means of steam jets or by fans. The former are generally applied in the ashpit for forcing in air which is made to pass upward through the grates. It has also been used to deliver air above the fires in the form of finely divided streams with a view to mixing it with the gases arising from the fuel bed. This system of producing draft is very costly, as a large amount of steam is used by the jets, and it also introduces a considerable quantity of water which has to be heated and carried up the chimney.

Upon the training of stokers Mr. Storie had the following to say:

Poking the fires is one of the principal causes of smoke production, and although the author is aware that there are times when this operation cannot be avoided when boilers are fired by hand, it is a practice which should be discouraged as much as possible, as it has become almost habitual with many firemen who have placed at their disposal clumsy tools of various forms.

The effects of good and bad stoking are often very marked. Some years ago a prize competition in hand-firing was carried out at Sheffield, and the difference between the best and the worst showed a gain of 22 per cent. in evaporation and 18 per cent. in boiler efficiency, with conditions exactly the same in each case.

A number of years ago a series of trials of Newcastle and Welsh coals were carried out on behalf of the Admiralty by T. W. Miller, and the following deductions from the report tabulated by the late D. K. Clark, show a loss of efficiency of 17 per cent. due to incomplete combustion:

Smoke Prevented		
Coal per Square Foot of Grate per Hour	Water Evaporated per Square Foot of Grate per Hour	Water Evaporated per Pound of Coal
21.69	3.46	11.05
Dense Smoke Produced		
25.81	3.26	9.19

In conclusion Mr. Storie dealt with the use of the heat, which is too often carried up the chimney with the waste gases, for preheating the air required for combustion. He said:

In many boiler installations, the air required for combustion is heated by the waste gases after they have left the boiler flues. The circulation of the air is effected by means of a fan placed at the outlet of the economizer chamber, which draws the gases through the tubes of a heater situated over the main flue at the back end of the boiler. The air for combustion which is drawn into the heater circulates outside the tubes through which the hot gases are passing on their way to the economizer. From the heater the hot air is conveyed in pipes to the furnace front, which is closed, and dampers are fitted to allow the air being admitted both above and below the fires. The providing of this hot air, which attains a temperature of about 300 degrees Fahrenheit, insures a sufficiently high temperature being maintained during combustion in conjunction with an intimate mixture of the gases. I have had some years' experience with a boiler plant arranged on this system and the results have been entirely satisfactory. On a carefully conducted trial, the boiler showed an overall efficiency of 77 per cent. and no smoke was produced.

At the Hammersmith central power station there is a similar arrangement to the one just described, with the exception that an additional heater is placed in the flue between the economizer and the fan. From this heater the air warmed by the waste gases after they have left the economizer is led in ducts to the heater over the main flue, to be further heated before entering the furnaces. It is claimed for this two-stage system that the temperature of the air entering the high-temperature heater is such that the fall in temperature of the gases passing through the second heater is greatly diminished, with the result that a higher feed-water temperature is obtained, and the final temperature of the gases entering the fan is reduced to about 280 degrees Fahrenheit.

Mr. Bibby's paper covered to some extent the same ground and dealt largely with the scientific principles of good combustion, and the means whereby these can be attained in actual practice. However, he took the somewhat unwise course of upholding a special form of patented mechanical stoker (now in use in the Liverpool works of his firm) as the most efficient and satisfactory mechanical stoker on the market. The stoker was described as follows:

In this machine the grate consists of a number of hollow bars about 4½ inches wide, which are laid side by side to make up the grate width. The fronts of these bars are trumpet-shaped, and the portion which goes into the furnace is U-shaped, open at the top. Into these bars are loosely fitted a number of horizontal grids, the tops of which form the grate surface proper. A steam jet blowing in front of each bar forces air through at a pressure sufficient to overcome the resistance of the fuel on the grate. The grids are so formed as to pick up the air forced in the bar and direct it where required in the furnace. The bars are made to travel to and fro in such a way that the fuel is carried forward, the majority of the bars going in together and returning independently to secure this action. At the front of the furnace is superimposed, across the grate, a series of grids. These grids are stationary, but are supplied with air from the trough bars through an inclined scoop. Small coal is fed onto the stationary grids from the hopper by means of two plungers to each furnace, the strokes of which can be separately regulated. The fuel, as soon as it is pushed onto the stationary grids, becomes heated from the fire in front of it; the volatile constituents are driven off and ignited through sufficient air being supplied through the scoop. The fuel is then in a coking state and is slowly pushed off these stationary grids by means of the dead fuel behind it, onto the moving grate, the motion of which carries it forward.

A leading feature of the furnace is to provide separately for the operations of coking and of complete combustion. The air spaces are so proportioned that the correct amount of air is supplied for each stage. The coked fuel is completely burned by the time it reaches the end of the bars. The quantity of air forced into the bars and the speed of the bars are under control, and can be regulated to suit any duty up to the capacity of the furnace.

He gave the following as the points which must be satisfied by any good mechanical stoker and furnace:

1. A means for regulating the coal separately to each furnace so that the bed of fuel is level transversely.

2. Independent provision for both the coking and full combustion processes, so that the correct proportion of air is supplied at the right periods for these processes, and perfect combustion is secured without requiring too great an excess of air.

3. The furnace should be divided into a number of sections, and each section should be supplied separately with the correct amount of air for the quantity of fuel that it is intended to burn per section, so as to prevent short-circuiting the air.

4. The bars should be given a horizontal motion in order to move the fuel, and the speed should be capable of regulation to suit variations of load and classes of fuel.

5. While the furnace is working there should be no opportunity for air to escape into the flues except through the furnace. A door should be fitted beneath the back of the furnace so as not to depend on the ash and clinker in the back chamber for preventing air being drawn in.

6. All the reduction gear should be machine-cut and in oil-tight cases, so that the machine will work under the adverse conditions found in many boiler houses.

7. An automatic means should be provided for discharging the ashes which fall through the grates.

In concluding his paper Mr. Bibby stated:

From a large number of careful experiments it has been found that, as a general rule, with a coking stoker of this type and bituminous coal, the steaming capacity of the boiler can be increased about 20 per cent. and the efficiency increased by from 5 to 10 per cent. over hand-firing. This result is being obtained without smoke, and in most instances firms that have adopted them have found that they can burn cheap fuel, which could not be used to advantage by any other means.

Exhibition of Appliances

The exhibition of smoke-abatement appliances which had been organized by the Manchester and District Smoke Abatement Society, with the support of various other societies, followed the lines that had been found so successful at Glasgow in 1910.

The largest number of exhibits related to the use of gas and electricity for domestic heating and cooking purposes, the domestic chimney being now generally recognized in England, as one of the chief contributors to the smoke-laden atmosphere of all large towns and cities. As regards the industrial section, the manufacturers of the well known types of mechanical stoker were all represented.

Among the special devices shown was Tyler's patent smoke preventer and fuel economizer for hand-fired furnaces. This is an apparatus which is fixed to the front of the boiler furnace for regulating the supply of air, both through the fire-door and at the back of the bridge-wall in such a way that the smoke resulting from hand-firing is combined with warm air in passing over the bridge-wall, thereby insuring the complete combustion of the smoke, and effecting a saving of fuel used.

The action of the appliance is controlled by a pair of springs acting on a horizontal oil cylinder or dashpot, which itself can be regulated, or timed, to permit the closing of the air inlets according to the class of fuel in use in any particular furnace. It is arranged so that only enough air is admitted to obtain complete combustion of the fuel,

and as the green coal gradually becomes incandescent, the admission of air is automatically decreased until the extra air inlets are almost closed. The operation is repeated each time the furnace is fired, the action being started by opening the fire-door. The apparatus is admirably adapted for use on boilers of the Lancashire and Cornish types, and a guarantee to prevent all smoke and effect economy in fuel is given in every case.

Many other devices of interest to steam users were exhibited but must be passed over for lack of space.

Failure of a Surface Condenser

The generating equipment at the municipal lighting plant at Fort Wayne, Ind., consists of two 500-kilowatt vertical Curtis turbines and a new 1500-kilowatt turbine of the same type, the latter having been recently installed.

The condensing apparatus for the new unit consists of a large surface condenser having twenty-two hundred ⅝-inch by 16-foot tubes through which the cooling water circulates. This water is obtained from a reservoir adjacent to the plant and is forced through the condenser by a 12-inch volute centrifugal pump driven by a small vertical engine. The vacuum is maintained by an 8 and 10 by 12-inch air pump. Both air and circulating pumps are located in a pit below the condenser opposite the turbine exhaust-steam outlet.

Early in the evening of Sunday, Nov. 12, the new 1500-kilowatt unit was running alone, being but partially loaded. Some difficulty was experienced in maintaining a good vacuum. The engineer in charge went into the pump pit to locate the trouble. Shortly, a tremendous explosion took place at that point and the engine room filled with steam. The switchboard attendant shut off the turbine and went into the pit to find the engineer. He had been instantly killed and lay under a section of the condenser shell. The attendant then started up one of the 500-kilowatt units and again took up the load just 12 minutes after the explosion.

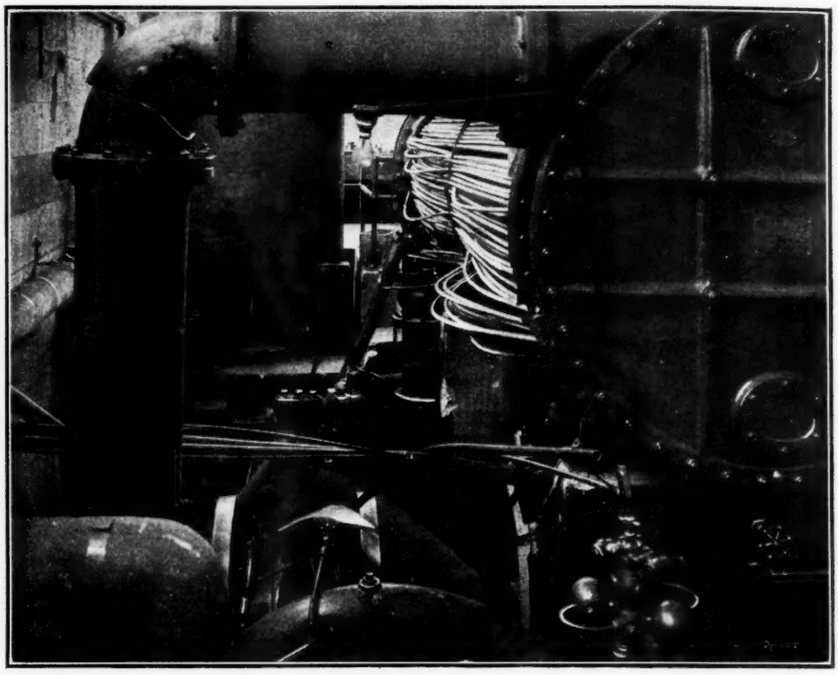


FIG. 2. END VIEW, SHOWING FRACTURE IN CIRCULATING PIPE

The cast-iron shell of the condenser was broken into several sections, the top half and that portion opposite the turbine outlet being forced off into the pit and against the station wall. In falling, the parts struck the circulating pump, the air pump and the adjacent piping. The housing of the circulating pump was broken off just below the flange, but it was not otherwise injured. The valve mechanism of the air pump was shattered. All steam piping and fittings for the air pump were demolished. Many of the condenser tubes were bent or dented, but the turbine was not hurt in any way. The accompanying photographs will serve to show the nature of the damage done.

The cause of the accident is not definitely known. It is evident that the turbine lost its vacuum and the condenser received steam under considerable pressure. Whether this was due to some fault in the air pump or to failure elsewhere cannot be determined from the evidence and information obtainable after the accident.

The turbine is supplied with a relief valve from which the atmospheric exhaust line leads downward, then through a butterfly valve and horizontally out of the station. It is possible that the relief valve failed to operate or that the escaping steam forced the butterfly valve temporarily closed.

There is little likelihood that there was sufficient water in the exhaust line to obstruct the free escape of the steam.

The equipment is now undergoing repairs.

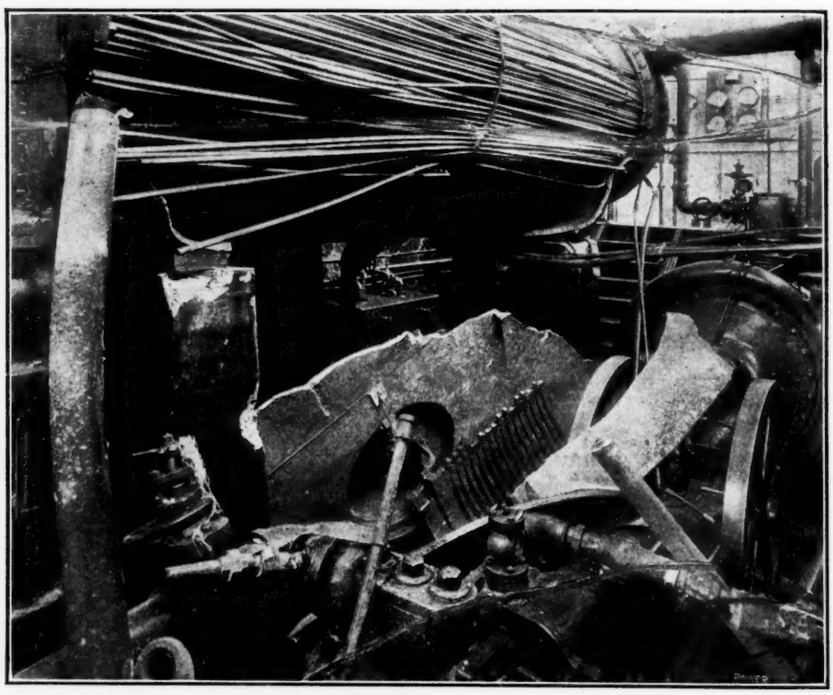


FIG. 1. RESULT OF CONDENSER EXPLOSION

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Catechism of Electricity

THE NERNST LAMP

1156. *Are there any other forms of incandescent lamps besides the filament types previously described?*

Yes. The one most closely related to the filament lamp is the Nernst lamp, shown in Fig. 389.

1157. *How is the light produced?*

By heating a high-resistance conductor in very much the same way as in the filament lamp.

FIG. 389. NERNST LAMP AND GLOBE REMOVED FROM HOLDER

1158. *What is the quality of the light given by the Nernst lamp?*

It gives a soft white light particularly well adapted for general illumination and decorative lighting.

1159. *What are the principal parts of a Nernst lamp?*

The glower, heater, ballast and cutout.

1160. *What is the glower?*

The glower is the conductor which is heated white-hot. It is shown at *G* in Fig. 390.

1161. *Of what is the glower made?*

It is composed of earthy oxides, such as thorium, zirconium and yttrium, mixed with suitable binding material.

1162. *How is the glower formed?*

The pasty mixture of oxides and binding material is forced through a die into the form of a small white porcelain-like tube, ranging in outside diameter from $\frac{1}{64}$ to $\frac{1}{16}$ of an inch and in lengths of ½ to 1½ inches. The tube is then baked to make it strong mechanically, and is finally cut to the proper length for the voltage to be used and closed at the ends. Platinum terminals are attached to the ends of the glower tube, after which a coat of oxides is put on as a protective covering against oxidation.

1163. *What is the life of the glower of the Nernst lamp?*

About 600 hours on direct current, 400 hours on alternating current of 25 cycles and 800 hours on alternating current of 60 cycles and higher frequencies.

1164. *What is the purpose of the heater?*

To raise the temperature of the glower, at starting, and thereby reduce its resistance. At ordinary temperatures the glower is of such high resistance that it is practically an insulator, but the resistance drops greatly when heated to a high temperature. To accomplish this, the heater is mounted close above the glower, as shown at *H* in Fig. 390.

1165. *How is the heater made?*

Of fine platinum wire wound on a round porcelain rod and covered with paste. The rod is then formed into a worm shape, and in this form is called a "wafer" heater.

1166. *What is the ballast and what is its use?*

After the temperature of the glower is raised by the heater until its resistance decreases enough to allow an appreciable current to flow, the heating effect of the current causes the resistance to continue decreasing, allowing the current to increase. When the normal operating point is reached, the decrease in resistance becomes so rapid that unless a steadying resistance, or "ballast" as it is called, is used in series with the

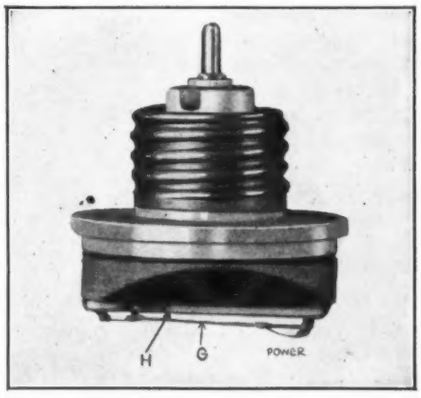


FIG. 390. BURNER OF LAMP SHOWN IN FIG. 389

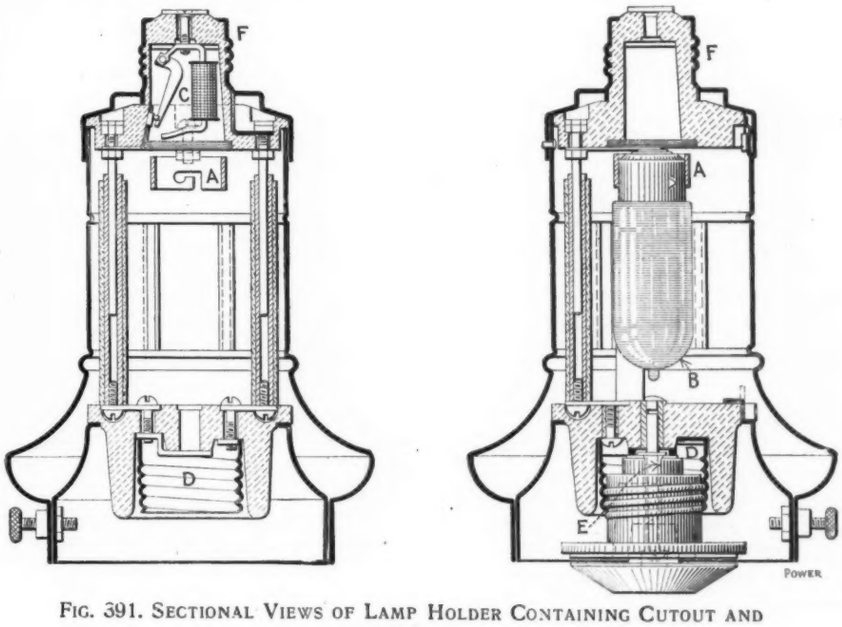


FIG. 391. SECTIONAL VIEWS OF LAMP HOLDER CONTAINING CUTOUT AND BALLAST

glower, the latter would soon burn out. The "ballast" conductor increases in resistance as its temperature increases and thereby counteracts the decrease in the resistance of the glower beyond the normal working point.

1167. *How is the ballast made?*

It consists of fine iron wire mounted in a small glass tube about an inch in diameter and 2 to 3 inches long, containing hydrogen. The reason for this arrangement is that the iron wire is kept at a very high temperature and must therefore be protected from the air to prevent oxidation and too rapid temperature changes. The ballast tube is mounted as shown at *B*, Fig. 391.

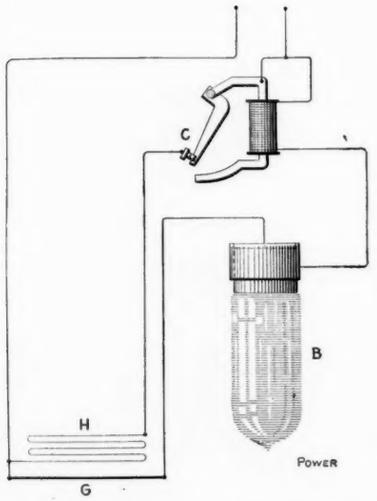


FIG. 392. DIAGRAM OF LAMP CIRCUITS

1168. *Why is hydrogen gas used for the ballast in preference to other gases?*

Because it will not attack the iron and is a very good conductor of heat.

1169. *Why is iron used for the ballast conductor?*

Because it is almost the exact opposite of the glower in temperature characteristic; that is, its resistance rises as the temperature is increased and at almost the same rate as that at which the resistance of the glower decreases, at temperatures in the neighborhood of the operating temperature.

1170. *For what purpose is the cutout used?*

As soon as the glower begins to pass current, the current keeps the temperature up and the heater is not needed. In order to prevent deterioration of the heater and unnecessary loss of power, the automatic cutout is provided to disconnect the heater from the circuit.

1171. *How is the cutout arranged?*

An electromagnet with a movable armature is mounted, as shown at *C*, Figs. 391 and 392, and the armature is held by gravity in the closed position when not attracted by the magnet. The winding of the magnet is connected in series with the glower and therefore the magnet becomes energized as soon as current begins to flow through the glower; then it attracts the armature and opens the circuit through the heater.

1172. *In what sizes are Nernst lamps made?*

They are rated at 66, 88, 110 or 132 watts.

1173. *How much light is given by these different sizes in comparison with that of a 16-candlepower carbon-filament lamp?*

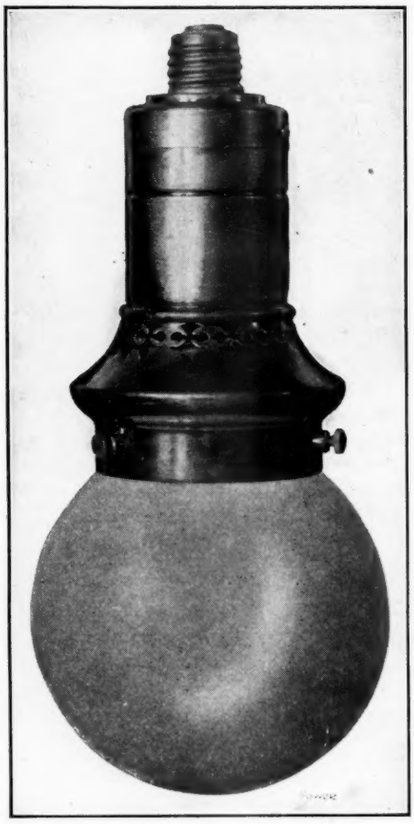


FIG. 393. COMPLETE NERNST LAMP

The 66-watt lamp is equivalent in illuminating power to three 16-candlepower filament lamps, the 88-watt lamp to four, the 110-watt lamp to five and one-half, and the 132-watt lamp to seven.

1174. *Explain the parts of the Nernst lamp shown in Fig.* 391.

In this drawing the socket shown at *A* takes the fitting on the end of the ballast tube *B;* the automatic cutout is located at *C*, the glower socket at *D* and the heater terminal contact at *E*. The screw plug *F* fits in the standard Edison lamp socket. The structure shown here in section is the upper part of the complete lamp shown in Fig. 393.

A smoke-abatement exhibition will be held in London, England, next spring. Arrangements are now being made by the Coal Smoke Abatement Society to have the exhibition held at the Royal Agricultural hall. It will cover a period of two weeks.

LETTERS

Wear of Bearings Due to Unbalanced Airgaps

It sometimes happens that dynamo bearings wear very rapidly on the bottom of the sleeve, due to unbalanced airgaps, which cause a stronger magnetic pull from the bottom poles of the field magnet than from the upper ones. The beginning of the rapid wear may be due to faulty design of the boxes, but it is much more probable that the field-magnet ring of the generator was set too high when the machine was erected, causing an excessive downward magnetic pull on the bearings from the start.

If the bearings have just sufficient surface to carry the load under normal conditions, any extra pressure, such as might be produced by an unsymmetrical airgap, would cause rapid wear, which would, if allowed to continue, become more rapid as the airgap on the side causing the excess pressure became smaller and smaller. The magnetic pull between the pole-faces and the armature core is considerable* and it should be equalized around the armature.

In alternators of large size, there being no commutation to contend with, it is customary to adjust the airgaps so that the pole-faces of the revolving field magnet will come slightly nearer the upper than the lower face of the armature core, thereby relieving the bearing of a part of the weight of the revolving member by the excess magnetic pull at the top airgaps. I once had an experience with unbalanced airgaps in a 32-pole alternator running at 180 revolutions per minute. Two adjacent field-magnet coils were damaged and in order to keep running until permanent repairs could be made, a jumper was put across these two coils, thereby cutting them out of the field circuit. We had no particular trouble in carrying the load, but vibration throughout the machine was noticed and by the time the new coils arrived (an interval of three weeks) the armature structure had been rocked out of alinement, making a readjustment of the airgaps necessary.

J. B. CLAPPER.

Lakewood, O.

Arrangements have been completed by the Imperial Russian Technical Society for an international engineering exhibition in April, 1912, at Baku, Russia. The exhibits will comprise internal-combustion engines, air compressors, electrical apparatus, etc. The exhibition will run for a period of six weeks. The exhibits will be grouped in Baku, and attractively arranged by the workmen of the technical society.

*The magnetic pull of a pole-face 10 inches square, delivering 5,200,000 lines of flux, is appreciably over 3000 pounds.—EDITOR.

Gas Power Department

A Small Producer Gas Power Plant in a Woodworking Shop*

By Albert W. Honeywill

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

The Lampson Lumber Co., of New Haven, Conn., some time ago installed in its woodworking shop a small anthracite gas producer and gas engine. The company manufactures inside "trim" and all the machinery for this purpose is driven by the gas engine.

The machinery consists of a molding machine, a 26-inch planer, a sander machine, a self-feed grip saw, a variety saw, a band-saw, a joiner, a cutoff saw, a boring machine, a lathe, an emery wheel, a knife-grinding machine and a fan to remove the sawdust and chips.

In the basement are located the engine room, the producer room and the pump and baling room. The engine room contains, besides the engine, an air compressor and compressed-air tanks, compressed air being used to start the engine. The producer room adjoins the engine room on the north and contains, in addition to the producer equipment, a boiler used to provide steam for heating the building in cold weather.

The engine is rated at 45 hp. at 160 r.p.m. and is of the hit-and-miss type, operating on the four-stroke cycle. The governor controls the gas valve only. The main inlet valve takes in a charge of air each time; consequently, when no charge of gas is admitted and no explosive mixture is formed, the air acts as a scavenging agent and removes most of the burned gases from the cylinder. The ignition system is of the jump-spark type.

The gas generator is of the ordinary suction type, with a "pan" vaporizer in the top of it. The grates are stationary and are located about a foot from the bottom of the ashpit, which is sealed. The wet scrubber is of the ordinary coke-filled tower type. Water from a tank near the roof is admitted at the top of the scrubber and is sprayed on the coke by means of perforated pipes. The gas passes from the top of the scrubber to a cylindrical steel tank of a volume about one-third that of the scrubber; this tank acts as a holder for the gas and also allows any moisture which has been carried over with the gas to settle in the bottom. The piping from the gas holder to the engine is short and direct.

The machinery is in operation nine hours a day, between 7 a.m. and 5 p.m., but the engine is kept running during the noon hour. The load, as is natural in a woodworking shop, is variable. The molding machine adds 20 hp. to the load and several of the other machines, such as the sander machine, the planer, the self-feed grip and the variety saws, are comparatively heavy, so that their use or idleness varies the load considerably.

The average coal consumption is seven tons of pea anthracite per month, or approximately 467 pounds per day. Assuming an average load factor for the shop of 40 per cent., this is equivalent to 2½ pounds of coal per horsepower-hour. The cost of coal delivered is $4.50 per ton, which would make the average cost per brake horsepower-hour 0.56 of a cent. No account is taken of the water as the only cost is that for pumping.

An analysis of the coal gives:

	Per Cent.
Fixed carbon	74.95
Vol. combustible	6.95
Moisture	3.35
Ash	14.75
	100.00

An analysis of the gas gives:

	Per Cent.
CO	20.9
H	6.7
CO_2	2.2
O_2	3.4
N	66.8

The average heat value of the gas per cubic foot is 89 B.t.u.

An analysis of the residue taken from the ashpit gives:

	Per Cent.
Fixed carbon	71.46
Ash	28.54

The producer is charged twice a day, at the time of firing up in the morning and again at night. More coal is used, however, in the morning than in the afternoon, the charging at the latter time often being omitted. The fire is poked regularly at 10 a.m, 1 p.m., 3 p.m. and again at night. The ashes are removed in the morning and at night. The attendant arrives at 6 o'clock and starts the engine at 6:45.

The producer is rather inconveniently located. In order to get headroom for charging it was necessary to place the producer in a pit about five feet deep. A small coal-storage bin of about two tons capacity is located at the side of the producer on the main-floor level. With this arrangement it is necessary to shovel the coal into small barrels and lift them to the top of the producer, and to clean out the ash it is necessary to climb down into the pit.

The time required to start from a cold condition is about two hours. The fire was pulled out on Nov. 5, after a continuous run of about eight months. Inspection of the interior showed the firebrick to be in good condition. Two of the grate bars were renewed at that time and a few have been renewed at previous cleanings. No other renewals or other repairs have been made since the installation of the producer, nearly a year and a half ago.

An Italian at $15 a week has charge of the engine and producer; his duties also include keeping the producer and engine rooms clean and baling the chips. The entire cost of power, including coal, oil and wages of attendant, are covered by the byproducts of the shop, which include baled chips, sawdust and partly burned coal from the producer. The ashes from the producer are screened and the half-burned coal obtained in this manner is used under the heating boiler and to heat a separate office in the lumber yard; any not used in this way is sold at $2 a ton.

The first cost of the plant, including producer, engine, blower and blower motor, was about $3500. The operating expenses per day are as stated in Table 1.

TABLE 1

	Per Day
Coal, 467 pounds	$1.05
Labor, one man at $15 per week	2.50
Repairs and depreciation, 10 per cent. per annum on first cost	1.16
Interest, 5 per cent. per annum on first cost	0.58
Oil and waste, etc	0.14
Taxes, 1 per cent. per annum	0.12
	$5.55

As previously mentioned, the residue from the producer is screened and the recovered carbon utilized for heating. For this reason it seems fair to charge only a portion of the coal to the producer because if only a small quantity of carbon remained in the ash it would be necessary to buy other coal for heating purposes.

In the course of the ensuing discussion, Mr. Honeywill explained that the

*Abstract of a paper read at the New Haven meeting of the American Society of Mechanical Engineers.

fact that the sale of chips, sawdust and partly burned coal paid the cost of plant operation was mentioned merely as a matter of interest; it has no bearing, of course, upon the cost of operating the plant. He also stated that his estimate of the average load (40 per cent. of the full load) was based on four or five inspections of the plant at different times and on estimates by the foreman of the number of hours each machine runs per day and the power each requires.

The Operation of Gas Power Plants

By J. C. Parmely

Perhaps the greatest obstacle preventing the more general adoption of gas power for commercial use in the past has been that this power was not considered reliable. This was undoubtedly true to a certain extent, and the reason was that competent operators were difficult to find and one of the strongest points made by over-zealous salesmen was that high-priced trained operators were not necessary to the successful operation of the plant. This the purchaser usually found was untrue, much to his sorrow. Now, however, this trouble is not so common and, too, successful operators are more easily obtained.

About the most necessary element in the makeup of a competent gas-engine operator is an ample fund of common sense. Besides this, the engineer should have a knowledge of the fundamental principles underlying the operation of the gas engine; should be thoroughly acquainted with the particular engine he operates; should know all about the electrical equipment of the station, including the storage batteries sometimes used in connection with the ignition circuits; should be a first-class mechanic and able to make any necessary repairs upon the machines intrusted to his care; should know the chemistry of the generation of producer gas—if he handles a producer plant—and several other things too numerous to mention. Is it any wonder that really successful gas-engine operators are difficult to find, or that the service was not always of the best during the early days of the gas engine?

One of the most useful helps in the operation of any machine is a certain routine of duties that is gone through with every time the machine is started or stopped. Every successful gas-engine operator will tell you this, for, by following his particular methods, he never, never, neglects to turn on his jacket water or pump up the pressure in the air receiver after starting. One routine established in a plant by the writer was as follows: One man would close the switch in the igniter circuit, turn on the oil in the main-bearing cups, go to the switchboard and raise the voltage on the generator as the machine came up to speed, plug in the synchroscope and put the generator on the busbars in parallel with the machine in operation. The second man would climb to the gallery of the engine, set the mixing valve for the proper starting mixture, open the valves in the gas line, and open the air-starting valve. As soon as an explosion occurred, which was usually during the first few revolutions, he would close the air-starting valve and go to the back side of the cylinders and open the valves in the jacket-water line while the engine was coming up to speed. He would then return to the front side of the engine, adjust the mixture valve for the running mixture and be prepared to reduce the speed of the engine with the governor, if necessary in order to synchronize the generators.

This process may seem long, but it was usually accomplished well within two minutes, when necessary to hurry, and in one instance an engine was started and brought up to speed with the voltage raised on the generator in one minute and the unit was operating in parallel with its mate twenty-five seconds later. This plant was equipped with Westinghouse three-cylinder vertical engines of 335 hp. rated capacity each. The fuel was natural gas.

The worst trouble experienced with this installation was with a piston that persisted in running hot. The first indication would be a light knock, when the engine was pulling about half load, which would increase very rapidly in an incredibly short time and the engine would stop within a very few minutes, if the load were not reduced. This difficulty was soon located, however, and found to be due to a crack in the left piston extending one-fourth the distance around the piston, and another about 8 in. long in the cylinder wall parallel to the axis of the cylinder. This was probably due to a short nap sometime when the water was low, and allowed enough leakage past the piston to heat it until it would expand and grip the walls of the cylinder. Upon removing the piston, the rings were found to be stuck in their grooves as solidly as though they were a part of the piston, and cold-chisels and hammers were needed to remove them.

The make-and-break igniter plugs were removed each week and cleaned and tested for grounds. The mixing valves were also cleaned each week for the air supply was taken from a rather dusty atmosphere and parallel operation of the units demanded that the mixing valves move freely in their bushings.

The operation of a producer-gas power plant is much more complicated than that of a plant burning natural gas. One plant in which the writer gained some good experience was equipped with two Münzel engines of 280 and 100 horsepower each, which were two-cylinder (twin) and single-cylinder engines, respectively. Gas was furnished by two producers of the same make, rated by the makers at 150 horsepower each. These producers delivered their gas to the same set of wet and dry scrubbers. Buckwheat coal was burned for fuel. The load required the operation of only one engine at a time.

In the case of the producer plant, the successful operation of the engines, aside from purely mechanical troubles, depends very much on the degree of common sense displayed in the operation of the producers. A prominent builder of gas-producer plants is quoted as saying that the best producer operator he ever employed was the laziest man he ever saw. This is without doubt very true, for producers of the suction type must be kept closed as much as possible and the quality of the gas made will not be uniform if the fire is continually being disturbed by poking. In this plant the fires were cleaned twice in 24 hours. The grates were shaken at this time and the fires poked down. The fires were poked again about midway between cleaning periods and coal was fed from four to six times per day, according to the load. It was found that the best results with regard to operation were obtained with the producers under light load and for this reason both producers were used continually during the 24 hours. The producers were under fire for as much as a year at a time.

For the first few months in this plant considerable trouble was experienced with preignition. This would occur at various times when the load conditions were entirely different. In some instances it was severe enough to slow the engine down considerably. It may usually be stopped, if noticed in time, by cutting down the supply of steam to the air entering the ashpits and perhaps opening the ashpit doors slightly, which allows the air to enter the firebed without having passed through the preheater. This will make a gas of poorer calorific value. It may also be helped by using a smaller ratio of air to gas in the cylinder, which gives a richer mixture and one that does not burn as rapidly as the most efficient mixture. After learning to successfully carry the engines through these bucking periods a change in cylinder oil practically put an end to trouble with preignition.

The question of preignition is one that has not been solved satisfactorily, as yet. Many think it is entirely due to the hydrogen content of the gas, but this cannot be true for gases containing as high as 25 per cent. of hydrogen have been used successfully; a gas containing the same amount of hydrogen will behave very differently at different times, and, further, pure hydrogen will not ignite at the temperature due to compression.

Heating and Ventilation

Hot Water Heating for High Buildings*

By Ira N. Evans†

Considered as power plant problems. Layout and operation of systems and apparatus

If often occurs that 300 or 400 horsepower in boilers are required for the heating of a large building, whether the electric power is furnished or not. Has it ever occurred to the engineer or owner that this same heating system, if made air-tight, would have the power to act as a condenser to produce vacuum and would thus greatly increase the power economy over noncondensing conditions?

Unfortunately it is almost mechanically impossible to make an ordinary steam-heating system air-tight, but the results claimed above can be obtained with a properly arranged system of hot-water heating under forced circulation and a large saving effected in the use of fuel on power and heating combined.

The commercial cast-iron radiator is unsafe under a water pressure greater than 100 pounds, so that hot-water heating has been limited to buildings of less than 14 stories, where the static pressure will be within the stated limit.

As these buildings have become greater in hight and area, the power load for lighting and elevator service has increased proportionately. Due to the mechanical difficulties of making the piping air-tight, it is impossible to take advantage of the increased surface of the steam-heating system to produce vacuum on the engines. They are operated at atmosphere and the exhaust steam is utilized in the heating system at the same pressure.

The necessities of the low-pressure steam-heating system have eliminated all consideration of a condensing plant outside of the expense of using city water for injection. The same considerations have prevented the use of the turbine, inasmuch as this type of machine is very costly to operate under back pressure or no vacuum, the steam consumption being about 45 pounds per kilowatt-hour on a 500-kilowatt unit exhausting at atmospheric pressure at full load.

The engines for high buildings are seldom compounded, and the whole subject is no further considered than the fact that exhaust steam is required for heating, seven months, and the amount is estimated under the conditions of no back pressure in zero weather.

This fixes the heating-surface temperature at 212 degrees at all times and observation in the afternoon in most office buildings will show open windows with the radiators turned on, thus wasting the heat to the outside. If the system could be operated at lower temperatures, this waste could in a great measure be eliminated.

The hot-water system herein described may be applied to the highest buildings, the engines or turbines operated condensing and the temperature of the circulated medium varied so that without shutting off the radiation the rooms will not be overheated.

The most economical feature in the operation of such a system is the fact that the temperature of the water can be varied from 200 to 100 degrees with a corresponding saving in heat units whether exhaust or live steam is used for heating. No more heating surface is required than for vacuum systems as the medium in zero weather is at the same temperature in both cases.

Figs. 1 and 2 show diagrammatically how a hot-water system may be arranged for a building of any number of stories, the power plant operated condensing all of the time and the heating system utilized as a condenser to the extent of its capacity at any given outside-weather condition. To reduce the static pressure on the radiators the system is divided into several independent units, utilizing the steam from a common source.

For buildings 12 stories and under, one system is all that is necessary regardless of the area covered, and the heaters and pumps would be placed in the basement, but the condensing feature hereinafter described could be applied. For buildings under 20 stories and more than 12, two systems would be required, and for buildings 20 or more stories in hight every 10 stories would require a separate system or unit, such as is shown in Fig. 2. The heaters and pumps can be placed in a room of little value. Places of this character, such as a poorly lighted room, can be found in almost all buildings, and at that the required space would not be more than 15x20 feet on every tenth floor. The most advantageous place would be next to the shaft carrying the boiler flue and exhaust piping. The separate heaters and pumps can all be placed in the basement by installing long vertical supply and return water pipes. The heaters would then have to be built to withstand the static pressure, but the pressure on the radiation would be within safe working limits.

The arrangement shown contemplates one supply and one return pipe to the various stories. Each floor is divided into one or more sections as shown and served by a single 1½- or 1¼-inch pipe, depending on the amount of surface and floor area, and the radiators are connected in shunt or out and back into the same pipe.

Fig. 3 shows how this pipe may be run behind a removable base, or it may be run between the sleepers carrying the finished floor. Under these conditions a 1½-inch pipe will take care of 1000 square feet of radiation and a 1¼-inch pipe will supply 600 to 800 square feet of surface with the same drop in head. Fig. 1 shows each floor divided into two sections, which would allow a maximum of 2000 square feet of surface to the floor. When the lower floors of a building are of greater area than the upper stories, an overhead system with single risers may be used for the lower portion, allowing the same capacity for each riser. For the tower the scheme suggested in the diagram will prove the most economical to install. The great advantage of this system is the elimination of all risers with the expansion pieces extending into the rooms and the ugly holes at the floor and ceiling in each case. If the pipe shown in Fig. 3 was run exposed on the base, there would be no more pipe showing than in the case of runouts to risers in most cases, and the breaks would provide amply for expansion. The main pipes for this layout would not be over 5 inches in diameter in any case with branches of 3 or 4 inches, which is no larger than the single steam risers in the ordinary building for each line of radiators.

Objection may be made to concealing the piping, and in the case of steam, due to the sudden expansion strains

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which do not occur on a hot-water system, the objection would be sustained. The writer designed a system for an office building in Boston where all water piping was concealed under the floors and behind the plaster and after 12 years the system has given no trouble whatsoever. The piping, however, was thoroughly tested for expansion and pressure.

As shown in Figs. 1 and 2, the heaters and pumps are connected in series, and horizontal main supply and return pipes only appears on every tenth floor. This piping might easily be run in the furred ceiling of the corridors. Under these conditions the covering for the piping would not be needed and the omission of automatic heat control would reduce the cost of installation of the water system to that of a low-pressure steam system, the extra cost of heaters and pumps necessary for the hot-water system balancing the cost of covering and control apparatus.

The live-steam heaters *L*, which are very small, connect with independent steam and return lines from the boilers; the condensation is thus returned by gravity to the boilers without pumping or releasing the pressure. Full boiler pressure may be used, and by throttling the individual returns any temperature may be maintained by allowing the condensation to back up and to cover that portion of the tube surface not required in the live-steam heater. The returns need not be over 1¼- or 1½-inch pipe. The pump capacity need not be over 15 horsepower.

When the main engines are operated 24 hours, motor pumps should be used throughout, but if the engines are to be inoperative at any time one steam-turbine pump should be used and one motor-driven pump. The steam-turbine pump could be connected to the steam line to the live-steam heater and exhaust into the exhaust heater. This would make the heating system independent of the engines at all times.

The exhaust line would be connected to each heater, as shown, and the engines operated at atmosphere when desired by opening the relief valve shown in Fig. 2.

The only precaution necessary in this system is to be sure the exhaust pipe is air-tight; this will present no difficulty if the proper material is selected before erection.

Each exhaust heater is provided with a single connection with a long drop and loop of pipe not over 2 inches in diameter. The intermittent siphon action of these lines will produce a vacuum and remove the air. The lines lead to a header which is connected to the condenser. A motor-driven pump should remove this condensation to the feed-water heater, where sufficient auxiliary exhaust steam should be provided to raise its temperature to 212 degrees before returning it to the boilers.

On a job of this kind as much of the machinery should be operated electrically as possible so as to load the turbine; at the same time the units should be selected with regard to the heating load.

The expansion tanks should be operated by hand with air pressure, as heretofore described, and there should be absolutely no connection between the water systems for the different levels.

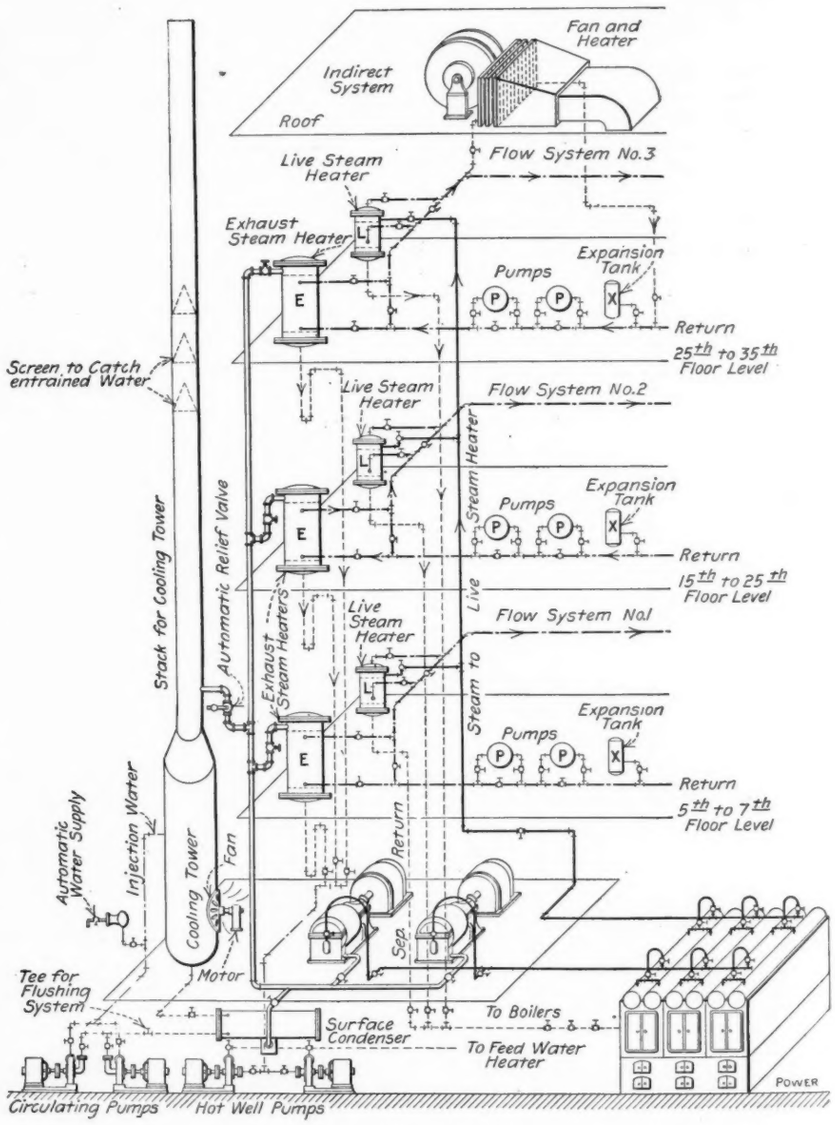

FIG. 1. DIAGRAM OF HOT-WATER SYSTEM PROPOSED FOR HIGH BUILDINGS

Objection may be made to operating machinery on different floors away from the engine room, but with proper water gages for each system corrected for difference in level the exact action can be determined in the engine room.

These pumps require little or no attention except at regular intervals and recording thermometers can be arranged to read the water temperature of each system in the engine room.

Fig. 4, which was taken from the September 12 issue, shows the steam consumption of a turbine under constant load that will just balance the heating requirements from 0 to 60 degrees by varying the amount of vacuum.

Curve *H* shows the heating requirements of a hot-water system of about 70,000 square feet of surface. Curve *T*, showing the steam consumption of a 500-kilowatt turbine unit under a constant load of 400 kilowatts and operating at different vacuums, shows an exact balance of the heating-steam requirements in temperature and amount.

The vertical distance between the curves shows the portion of the work on the condenser which is nearly constant throughout the heating season and about 2000 pounds per hour, or 20 per cent., of the requirements of a 500-kilowatt load at 20 pounds per kilowatt-hour under 28 inches vacuum.

It is due to this proved condition that a turbine-unit, cooling tower and con-

denser properly balanced to utilize the exhaust steam under partial vacuum on a hot-water heating system will prove 38 per cent. more economical for the combined heating and power than a vacuum system and engine plant operating at atmosphere with no vacuum.

Engineers as a rule will state that a condenser will not pay as their assertion is based on curves H' and T'', which would be nearly constant with a vacuum-heating system under all weather conditions.

In Fig. 1, a cooling tower with surface condenser, is shown recirculating the water for condensing purposes. A fan and motor would have to be provided or, where possible, the air for the tower could be combined with the engine-room ventilation, the hotter air being very efficient for cooling-tower purposes. A flue provided with conical wire screens should lead from the cooling tower to the extreme top of the building to carry off the vapor and prevent condensed water from falling on the roof and street. The cooling tower might be operated with natural draft in winter and the fan and motor shut down with corresponding reduction in operating expenses.

Where possible, a driven well could be provided with an air lift to furnish the water supply for the injection which is evaporated by the cooling tower. After passing through the condenser the water could be used for flushing the closets, providing an equal amount of cooler water to replace that removed, and materially assisting the action of the condenser. This arrangement would reduce the city-water bill for power and flushing purposes where well water for boiler use would be unsuited, due to impurities.

By installing a turbine the use of cylinder oil is eliminated and distilled water is obtained for the boilers.

Two motor-driven circulating pumps would be provided to circulate the injection water and the vacuum on the system could be varied by throttling the circulation or varying the speed of the pumps.

It may be readily seen that the cost of operating this condensing apparatus would be negligible in many cases in connection with the heating system except for the interest on the additional investment.

When less power is generated than the balanced load, the vacuum will have to be reduced, to increase the quantity of steam to maintain a proper water temperature on the heating system.

It will not pay to carry normal vacuum for that outside temperature and operate the live-steam heater to furnish the additional heat, although the apparatus is arranged so that this could be done.

Unless great caution is used, if both heaters are operated in conjunction, with the exhaust heater under vacuum, the latter may be cooling the water heated by the live-steam heater, thus entailing a heavy waste.

In the ordinary office building the load for lighting and elevators during the winter days is a little more than 50 per cent. of the peak. At such times the turbine would have to operate on a lower vacuum than the maximum that will furnish the proper water temperature, but the underload on the turbine with increased steam consumption per kilowatt-hour would be no added expense as it would be demanded in any case by the heating requirements.

When the peak comes on in the afternoon for three or four hours the heating requirements are minimum and a slightly higher vacuum can be carried than the outside-heating requirements demand without causing complaint. If the outside temperature were 35 degrees, the average in the vicinity of New York, 24 inches instead of 20 inches could be carried and the full condensing power of the heating system utilized with the condenser assisting. The low-steam consumption of the turbine for overloads would make an economical arrangement for the peak load. It might be policy where the heating was in excess of the power load to install only one-half the condensing capacity, operating the machine in summer on such vacuum as could be obtained. The total steam from the power load might be such that one-half the condensing capacity at full load and vacuum would produce a fairly high vacuum at one-half load.

If a condensing capacity for 6000 pounds of steam per hour were installed for a 500-kilowatt unit in conjunction with the heating instead of 10,000 pounds, or 500 kilowatts at 20 pounds, 28 inches of vacuum would be produced on a 250-kilowatt load at 23 pounds per kilowatt-hour. In winter this would be ample to maintain with the heating any vacuum desired at full load.

In case the building was not large enough to require a load that would warrant a condenser and a cooling tower,

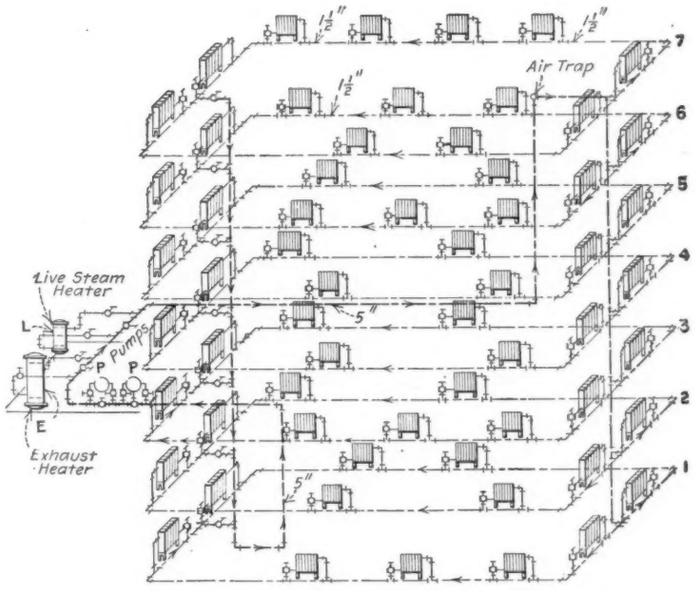

FIG. 2. ONE UNIT OF HEATING SYSTEM COVERING SEVEN FLOORS

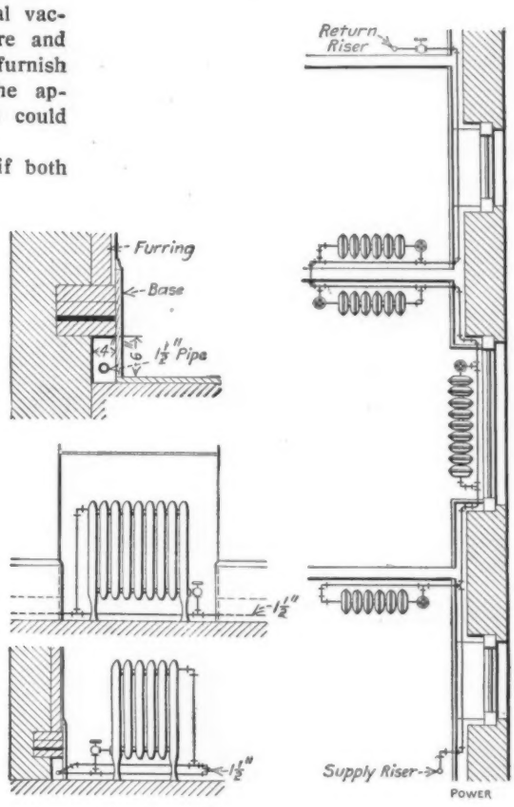

FIG. 3. RADIATOR CONNECTIONS

a fresh-air supply could be arranged on the roof with a fan and indirect stack connected to one of the hot-water systems. This would form an efficient air condenser and the ventilation of the building could be accomplished at the same time. This would be especially desirable where the power load was somewhat less than the heating requirements and not large enough to warrant condensing apparatus. The fan system is indicated in Fig. 1.

The time the building ventilation would be most desired would be in moderate, damp weather when the heating system would be at low condensing capacity. In very extreme weather the fan ventilation would not be as necessary and the heating system would have greater efficiency as a condenser.

From the article published in the September 12 issue the saving of the hot-water system during night operation, when live steam is used, is shown to be 35 per cent. over the low-pressure steam system at 212 degrees, due to the ability to change the temperature of the circulated water to suit outside-weather conditions. The gravity return of the condensation to the boilers under high pressure and temperature over the reducing-valve pump and receiver method enhances the saving 10 or 15 per cent. and would balance the percentage of radiation turned off in moderate weather when the steam consumption is figured at 212 degrees and all surface is in operation.

The extra cost would involve circulating pumps, a cooling tower and a condenser, with the piping connections.

If the temperature of the air averaged about 35 degrees and the temperature of the water 155 degrees, the average vacuum would be 20 inches. The steam consumption of the reciprocating engine of the best type at atmosphere would be 25 pounds of steam per indicated horsepower. Allowing 20 per cent. for friction of the engine and miscellaneous losses, a kilowatt at the switchboard would require 40 pounds of steam per hour. The turbine with 500 kilowatts load at the switchboard and 20 inches of vacuum requires 30 pounds per kilowatt-hour. This shows a saving of 10 pounds of steam per kilowatt-hour.

Allowing 1500 hours per year (5 hours per day for 300 days) for the peak load of 500 kilowatts, 8 pounds of evaporation per pound of coal and $4 per ton of 2000 pounds for fuel, the saving would be

$$\frac{500 \times 1500 \times 10}{8 \times 2000} \times \$4 = \$1876 \text{ per year}$$

The total cost of the cooling tower, pumps, condenser for 500 kilowatts at 20 pounds under full vacuum, or 10,000 pounds of steam per hour, is $8000 erected. The saving with this equipment installed would amount to 23.45 per cent. of its cost.

The saving on a 300-kilowatt plant would be somewhat less in proportion, but would still leave ample margin to warrant the adoption of this type of plant.

In plants under 250 kilowatts it would be better practice to use reciprocating engines compounded and operate on such vacuum as the heating system will produce with outside-weather conditions, omitting the cooling tower and condenser.

From observation, it is found that generally there will be about 100 square feet of heating surface to the kilowatt of power in buildings of this class and that the steam for the day load can easily be condensed in the heating system.

It is impossible to give more than an outline of the scheme in the space allotted and the problem can be developed only when a concrete case is presented. But if the system was adopted along the lines presented, with fairly intelligent operation, an isolated plant should produce current at the switchboard for the owner at a very low cost.

The saving involves the double effect of reducing the steam for power and the steam for heating at the same time. The condenser takes the slight hourly excess of the steam for power over heating and prevents this excess heat from accumulating and destroying the condensing effect of the heating system.

It should be remembered that there are ample precedent and engineering data to assure results as stated. The system would be particularly advantageous for hotel work, where night-and-day operation is obligatory. The flexibility of water heating would here show up to advantage over a medium which must be maintained at 212 degrees.

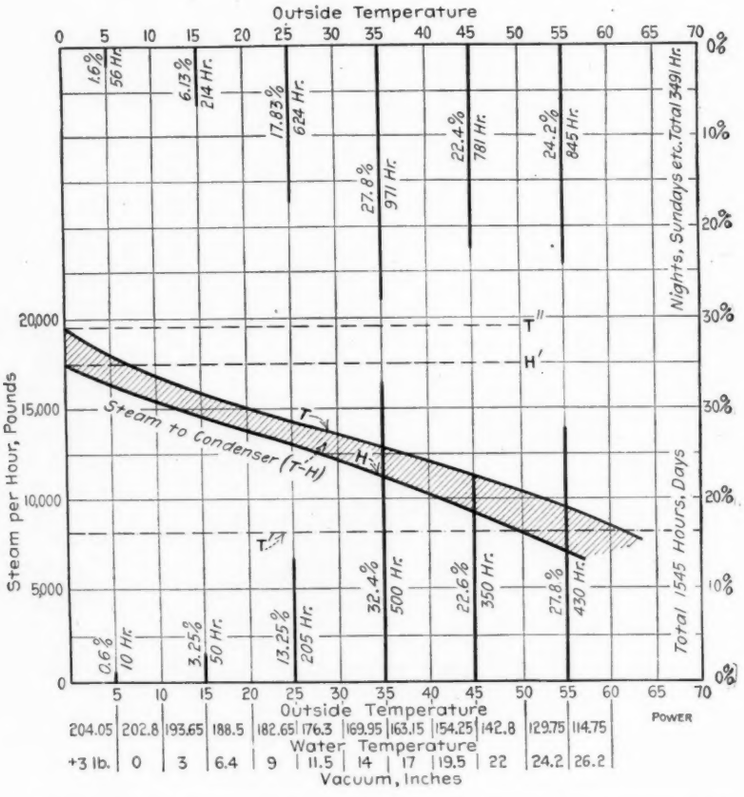

FIG. 4. CURVES SHOWING RELATION BETWEEN STEAM CONSUMPTION OF TURBINE AND REQUIREMENTS OF HOT-WATER HEATING SYSTEM

The insertion of a check valve in the gas-supply line between a suction producer and a gas engine operated from it has been found effective at a number of gas-power plants in reducing the troubles arising from backfires in the intake line caused by poor gas at times of cleaning the producer or changing the load, says *Mechanical World*. Without the check valve the backfire in the supply main usually partially consumes the gas in it back to the purifier or scrubber, and so weakens it that, particularly in case of a long gas-supply line, a considerable period intervenes before gas of a good quality again reaches the engine; this causes a serious drop of speed in the latter, or sometimes even a stoppage. By placing a swing check valve in the line close to the engine throttle and opening toward the latter, such a backfire cannot reach the gas beyond it, and has no appreciable effect on the engine's operation.

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POWER

Good Engineering Judgment

The value of an engineer is measured by his ability and his trustworthiness. These qualities are dependent upon two things: knowledge of facts and good judgment. Either of these is of little value in the makeup of the good engineer unless accompanied by the other. A knowledge of facts is essential, but it is also necessary to know how to apply those facts. This is the reason why the "textbook engineer" is so universally berated; he has not acquired the requisite judgment with which to apply his knowledge.

The way to obtain a store of knowledge is open and clear. Facts seemingly difficult to master become a personal possession after an application of determined perseverance and courage. Patience is required, indeed, and also those habits of discipline which are so necessary to the efficient engineer. The sources of engineering knowledge are conversation with experienced engineers, observation of things and affairs, the study of good engineering books and the reading of the leading engineering journals.

The means by which to acquire good judgment are not so apparent. This is largely inherent in the man, but, of course, may be cultivated to some extent. Good judgment is the result of experience, and experience may be acquired by storing away the lessons which are taught daily in the doing of ordinary tasks and by observing the experiences of others. It is a silly person who will repeatedly make the same mistake and repeatedly suffer the same punishment therefor.

Good judgment is fostered by a careful reading of current technical literature. The technical papers contain a wealth of material which tells of the experiences of others. These articles should be studied in a spirit of fair-minded criticism. Has the writer told of an experience which will be of assistance to you in a similar need? Well and good. Are your conclusions the same as his, or are you able to improve upon them?

In an emergency, dependence must be placed upon good judgment. It is well to anticipate an emergency. Many times every day the safety of life and property depends upon the quick decision and the immediate action of the engineer. Nowhere is this more apparent than in the operation of a power plant. In the engine room the operating engineer is frequently called upon to meet an emergency. A quick decision is more likely to be correct if it is based consciously or unconsciously upon a carefully thought out plan. Such a plan cannot well be formulated unless the emergency has been anticipated.

Good engineering judgment is not a haphazard accomplishment. The engineer who possesses it is respected and admired, but many do not stop to think that he has acquired it by constant and continuous effort.

Water in Ashpits

The practice of putting water in the ashpit, ostensibly for the purpose of preventing the formation of clinker, has many adherents among firemen and engineers, while, on the other hand, there are many who claim that the effect is merely imaginary.

It is now generally conceded that the formation of clinker is due to low fusing temperature of the ash. If this temperature is less than that of the fire, the ash will fuse and flow to the bottom of the fuel bed, where, coming in contact with the colder air from the ashpit, it solidifies either in the form of large clinker or spreads over the grate bars, thus obstructing the air passages.

Steam jets under the grates have been found to reduce the clinker to some extent, presumably by lowering the temperature of the fire to a point at which the ash will not fuse so easily. Whether the relatively small amount of steam formed from the water in the ashpit

would accomplish this purpose is questionable. If the difference between the temperature of the fire and that corresponding to the fusing temperature of the ash were small it is conceivable that the heat given up in dissociating the steam might be sufficient to reduce the temperature of the fire through this range; but where the fire is several hundred degrees hotter than the fusing temperature of the ash it is doubtful if this action would occur.

Water in the ashpit, however, does serve two other useful purposes: First, it absorbs much of the heat which would otherwise be radiated back from the hot ashes to the underside of the grate bars and thus protects the latter; second, by wetting the ashes, fine dust is prevented from spreading over the boiler room whenever the grates are dumped or the ashes removed.

These latter considerations alone are enough to warrant the practice being adopted under certain fire-room conditions, which may or may not be such as to render effective this means of preventing clinker.

New York State's Water Powers

The question of conserving the water powers of New York State was once more brought to the front when the joint legislative committee having this subject under consideration met recently and listened to testimony from Gifford Pinchot, ex-President Roosevelt and others prominently identified with the movement.

It was estimated that fully two million horsepower could be made available by the development of these water powers. Furthermore, if carried out along proper lines, such a development would serve the additional purpose of regulating the flow of the Hudson, Genesee, Black, Oswego and other rivers. Most of these at certain seasons are so swollen as to flood and do considerable damage to property along their banks, while at other times they are almost dry.

As all navigable streams are under federal control while the others come under state supervision, there has been a division of authority; hence a solution of the problem demands coöperation of these two branches of the government.

It appears that prior to the present agitation, the government had been in the habit of making perpetual grants of water powers to private interests without receiving anything in return or making provision for adequate supervision and regulation. Under these conditions many grants had been taken up for speculative purposes which have not been developed and the parties concerned now deny the right of the government to act further in the matter.

Some of those present at the conference were in favor of the state taking the initiative and constructing the necessary dams, etc., then selling the privileges to power companies. However, objection has been advanced to this proposal in that, according to the plans suggested, it would involve an enormous expenditure for which state bonds would have to be issued. The amount of power used might, for a number of years, be only a small part of that made available; consequently the rentals, which would necessarily have to be nominal, would not be sufficient even to pay the interest upon the investment.

A much better plan, it would seem, would be for the state to undertake such work upon a smaller scale and only when it was reasonably sure that the demand for power within a few years will warrant a return sufficient to cover the interest.

Or, on the other hand, it might be advantageous to permit the developments to be carried out, as needed, by private capital under lease. This would not necessarily involve the surrender of any state's rights, as public-service corporations are now beginning to acknowledge the justice of governmental supervision.

Of course, no private corporation can be expected to enter into any enterprise unless it can see a fair profit ahead, and any arrangements made with the state must take cognizance of this; but state supervision can, by fixing equitable rates, prevent excessive profits at the expense of the public.

In this connection it may be remarked that the rights of the public can be preserved against oppressive rates and monopolistic control by a provision permitting the state at any time to step in and operate its own utilities.

"Trade" or "Profession"

Steam engineering is considered by some people a profession, while others scoff at the idea and insist on calling it a trade. It really makes very little difference how it is classified, but to those who like to dwell on the subject the following quotation may open up a new line of thought.

In an article which appears in a recent issue of *The Youth's Companion*, entitled "The College in the Service of the Nation," President Hadley, of Yale, has this to say:

> Most people think that a profession is a business like law or medicine or teaching, which requires a great deal of learning for its successful exercise. On the other hand, they apply the name trade to a business for which a boy prepares himself in the office or the shop, and which does not demand book knowledge as a basis for its successful prosecution.
>
> This is not the right way to look at the matter. The real difference lies not in the character of the business, or in the kind of learning that is needed for its pursuit, but in the spirit in which it is carried on. Any business, however scientific, which a man does primarily for the sake of the money that he can get out of it is a trade. Any business, however simple in its character, where a man thinks first of the work that he is doing and only secondarily of the pay that he is going to get for it, deserves the name of a profession. If a carpenter thinks more of the solidity of his work than of the profit that he is going to make from it, he has the right to call his carpentry a profession. If a minister thinks more of the pay that he is going to get for his sermons than of the souls that he is going to convert by them, he has no right to call his business anything but a trade.

Doctor Hadley's definitions of "trades" and "professions" are radical departures from the generally accepted meaning of those terms. But if he is right, then, judging from the pay that most engineers receive and the contentment with which they receive it, yea, verily, they are not tradesmen; they are professionals of a high class!

All steamships have a system of thorough inspection in the engine rooms, both during each watch and on changing watches. The small "thickness" between the men and the deep blue sea is doubtless an incentive for additional care. But "thickness" works both ways, as was evidenced by a remarkable explosion in New York City on October 20, when a return-tubular boiler 15 feet long and 60 inches in diameter plowed through 150 feet of obstructions under a sidewalk, including a 3-foot brick partition wall. Carelessness and thickness are synonymous when it comes to a question of explosion and breakdowns.

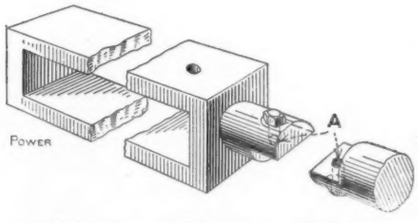
Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Broken Valve Crosshead

The small head-end steam-valve crosshead on a 1000-horsepower cross-compound Green engine had given considerable trouble. The engine had been in operation about one year when the bolt between the valve stem and crosshead sheared right off at *A*, shown in the illustration. The oiler and the assistant engineer were much surprised to see the receiver pressure suddenly drop, and then fluctuate from a vacuum to a very few pounds pressure.

After the trouble had been located the cutoff was changed on the crank end to maintain a steady receiver pressure slightly above zero. But this did not help matters, as the high-pressure cylinder was discharging steam into the receiver to make up the loss and the low-pressure valve was wide open. The



WHERE THE CROSSHEAD BROKE

problem was how to get the valve shut.

The broken bolt was removed and a wooden block was put under the nut to hold up the toe from the tappet, the rocker shaft being at rest. A piece of heavy copper wire was passed through the hole in the end of the valve stem, making a loop through which the end of a crowbar was passed. With this arrangement the valve was closed.

The cutoff was then adjusted to let the steam through on the crank end and a new bolt was put in, to hold the valve stem and crosshead together, while running; readjusting the cutoff completed the job.

About a month later the crosshead parted, as shown in the illustration, leaving the valve open. It was finally closed and the toe blocked up so as not to engage the tappet until the engine could be shut down, as the back of the crosshead struck against the crosshead of the crank-end valve stem. The broken crosshead was removed and the engine started and ran three legged, so to speak, with the high-pressure cylinder and one end of the low-pressure cylinder until a new crosshead was obtained.

There was always excessive wear of the adjusting wedge on this crosshead and the bolt and the toes met with frequent accidents by being broken off on the corners; the tappets were occasionally nicked on the corners. The steam-chest cover was removed but no sign of an obstruction to the operation of the valve was found.

This engine was frequently overloaded, often carrying 1200 horsepower, and the receiver pressure would run from zero at no load to 18 pounds at full load, condensing.

If this excessive receiver pressure could spring the center of the gridiron valve down enough to make it catch in the grid seat, the cutoff or closing edges failed to show it, as they were as sharp as a knife edge.

The high-pressure cylinder, too, has had its share of the head-end valve sticking, but the only damage was the wearing of the toes and nicking the tappets.

Can any of the readers of POWER give any intelligent suggestions as to the cause of this trouble? Cylinder oil is used very freely on this engine and the valve and seat show a very smooth glazed surface.

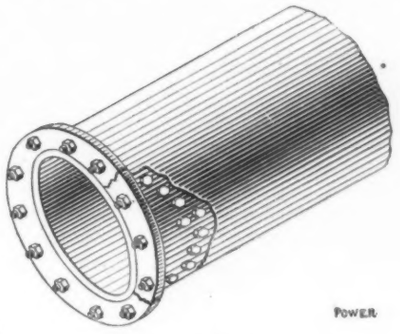
R. A. CULTRA.

Cambridge, Mass.

Bushed the Cylinder

I was once called upon to make a quick repair on a planing-mill engine. A broken piston rod had knocked out the cylinder head and with it a portion of the cylinder. The break in the cylinder was about 14 inches, or one-fifth of the cycle of the cylinder and about 6 inches deep toward the crank end. The shape of the cylinder was such that it was impossible to use tie bolts from the heads to the crank-end cylinder. The engine was of 150 horsepower capacity, but was only developing 90 horsepower.

I took the cylinder to a local shop, had a bushing turned and pressed into the broken cylinder. I then bolted the new cylinder head on to force the broken portion of the cylinder in place and then drilled through the broken cylinder with 5/8-inch holes, 3/4 inch deep in the bushing, which was 1 inch thick. The holes were for 5/8-inch cap screws and the broken piece was bolted on the same as a soft patch on a boiler. This job proved



BUSHED CYLINDER

entirely satisfactory. It is shown in the illustration. A repair of this kind could not be resorted to if the engine were properly loaded. The job cost $42.

J. H. DIXON.

Bamberg, S. C.

Unloader Gave Trouble

About two months ago I had a 12x8-inch air compressor installed which was used for a humidifying system and air-cleaning textile machinery. This machine is fitted with what is called an unloader which automatically opens and shuts the inlet to the compressor, to suit the requirements of the system.

The device was set to maintain 35 pounds pressure. When first started up it ran for two or three days with a variation of 4 pounds, opening when the pressure was reduced to 31 pounds and closing at 35 pounds per square inch. After running three days, the oil cup was filled with oil to lubricate the air-cylinder piston and this made things worse as the variation in pressure became greater, ranging between 35 and 25 pounds.

On investigating the unloader I removed the air-cylinder piston and found that it was not being lubricated. This was due to the flow of air at 35 pounds pressure forcing its way between the air-cylinder piston and the cylinder wall, there being no rings on the piston. This leakage of air was caused by a too small airport in the head of the air-cylinder piston, and it was also necessary to give the regulator-valve spring more tension

than should have been necessary, thus forcing the air between the piston and the cylinder wall, which carried the lubrication out into the intake pipe to the compressor.

It was found that the housing around the diaphragm formed a receptacle for sediment and any oil which might drip in when the compressor was shut down as well as the moisture which came through the air pipe with the air. This settled on the diaphragm and added more weight to it, thus keeping the needle valve open longer. The small airport in the head of the piston, which took longer to exhaust when the needle valve was

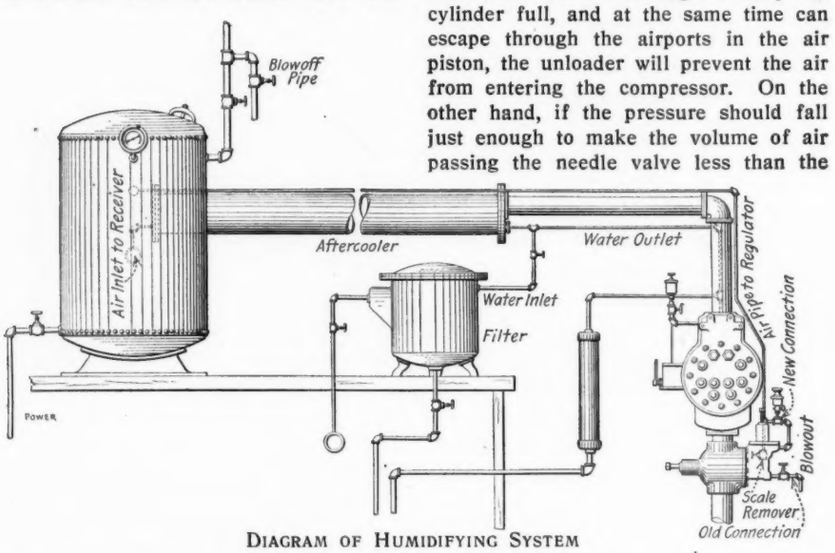


DIAGRAM OF HUMIDIFYING SYSTEM

shut, was relieved by drilling three $\frac{1}{64}$-inch holes in the head of the piston.

This made it work between 2 pounds variation but the piston soon ran dry and the diaphragm became loaded with moisture, oil and sediment.

All of this trouble was overcome by turning the air cylinder and diaphragm housing upside down and leaving the regulator body in its original position. I used the oil-cup connections for a blow-off in case any sediment, oil or moisture accumulated. The new connection for the oil cup is on the air inlet to the diaphragm chamber, and the oil enters the air pipe, lubricating whatever it comes in contact with. This tends to keep a thin film of oil around the point of the needle valve and also around the piston and the cylinder walls.

Once the piston is lubricated it is oil packed, and having larger airports and more of them, allows the air to exhaust more freely; also, the regulator-valve spring does not need any more tension than is necessary to overcome the friction of the valve and cylinder. The air comes down from the receiver just before it enters the diaphragm chamber and enters a scale and moisture pocket at the bottom of the air pipe, as shown in the illustration. About 8 inches from the bottom there is a tee which leads to the oil cup, then to the diaphragm chamber, carrying with it what lubrication leaves the oil cup. This oils the needle valve, making an oil seal when the needle valve is shut, thus allowing the air to exhaust and the unloader to open; then the compressor raises the pressure to 35 pounds, and the diaphragm pushes back against the diaphragm spring, opening the needle valve and allowing the air to pass behind the air-cylinder piston. This forces the regulator valve shut and cuts off the air entering the compressor.

If the pressure is high enough to cause the diaphragm to hold the needle valve open, and if the amount passing through the needle valve is enough to keep the cylinder full, and at the same time can escape through the airports in the air piston, the unloader will prevent the air from entering the compressor. On the other hand, if the pressure should fall just enough to make the volume of air passing the needle valve less than the capacity of the airports in the air piston, the regulator-valve spring will force the valve open. If the needle valve should leak, air will escape through the airports in the air piston. By adjusting the regulator-valve spring a variation of from ¼ to 5 pounds can be obtained. This could not be done before the change was made; the device has now been working satisfactorily for two months.

GEORGE MORTON.

Southbridge, Mass.

Test of Pumping Engine

It may interest some of the POWER readers to know of my latest pumping unit, installed at the city municipal pumping plant at Phoenix, Ariz., about a year ago. Here it is:

Duration of test, 8 hours.
Size of engine, 12½x30x30 inches.
Size of water end, 13¼x30 inches.
Revolutions per minute, 51.
Gallons per revolution, 70.4212.
Foot-pounds per hour, 233,787,457.
Steam used in 8 hours, 13,459 pounds.
Foot-pounds duty per 1000 pounds dry steam, 141,214,380; line pressure by gage, 47 pounds.
Suction lift in feet vacuum gage, 9.
Total head in feet by indicator diagram, 130.19.
Mean effective pressure in water cylinder, 56.5 pounds.
Indicated horsepower, steam, 126.
Indicated horsepower, water end, 118.
Mechanical efficiency, 93.6 per cent.

During the month of June, 1911, with a load factor of only 50 per cent. I pumped with this same unit an average of 7000 gallons of water per gallon of crude-oil fuel. The crude oil cost 4 cents per gallon.

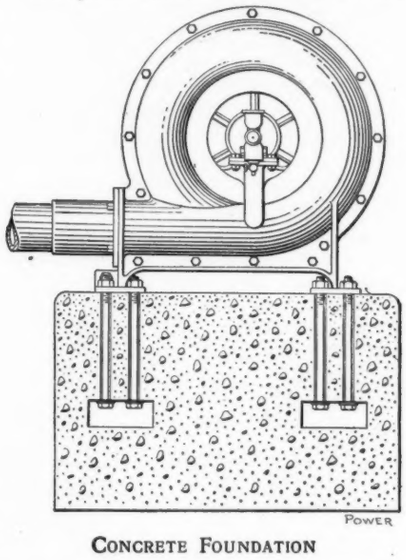
J. F. REYNOLDS.

Phoenix, Ariz.

Small Machine Foundations

There are various ways of installing machinery. Some men will put a machine on timbers set into the earth; some will use brick foundations, but the cheapest and best foundations are built of concrete.

The sketch shows a small blower resting on a concrete foundation built in box form and having pockets on the interior for the bolt head from the top. The plugs used in forming the bolt holes taper but by smearing them with black oil; they easily withdraw, leaving a nice clean hole in the foundation. A blower or generator set on this kind of foundation will last much longer than if bolted to springing timbers with their constant vibration.



CONCRETE FOUNDATION

C. R. MCGAHEY.

Baltimore, Md.

A Pumping Problem

I am operating two 48-inch double-suction, engine-driven centrifugal pumps. The engines are compound condensing and run at 110 revolutions per minute. When the river is at medium stage the pumps operate against an 8½-foot head.

The engine governors are disconnected and the engines operate with a fixed cut-off. The curious thing is that the engines slow down and the load on them increases as the river rises and thus cuts down the head.

Who can offer an explanation?

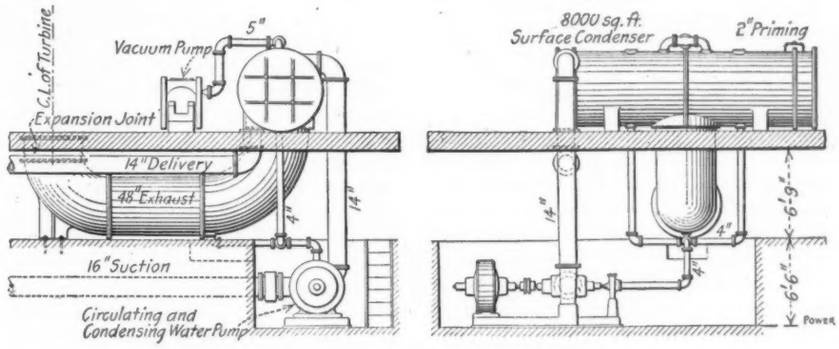
R. B. CROCKETT.

Canicetor, Texas.

Unusual Arrangement of Condenser

The condensing equipment shown in the accompanying sketch is being installed in an Eastern power plant. The installation is interesting as the layout of the machinery as well as the piping is unusual.

The prime mover is a 2000-kilowatt horizontal turbine with a 48-inch bottom-exhaust connection to an 8000-square foot, two-pass, countercurrent surface condenser.



ARRANGEMENT OF CONDENSING OUTFIT

An unusual feature is the placing of the condenser in the generator room, which was necessary on account of the small headroom in the basement, the distance from the floor to the ceiling being only 6 feet 9 inches. The condenser flanges are 6 feet in diameter, so for that matter it could have been placed in the basement, but this would have called for a side exhaust, which is much inferior to a bottom connection.

The tube heads in the condenser were too far apart, for the tubes to be left unsupported, so the condenser shell was cast in two parts and a tube-supporting plate placed at the center line of the exhaust inlet.

Another reason for splitting the condenser shell was the extreme difficulty in casting a shell of that length in one piece. To allow the tubes to expand and contract, they were given a loose fit in the supporting plate, expanded into one tube head and ferruled into the other. A 2-inch priming pipe with a valve connects the steam space with the rear water chamber of the condenser.

The condensing water is taken from the bottom of the condenser through two 4-inch pipes, one from each half of the condenser shell. To take care of any condensation that would collect in the exhaust pipe, a 4-inch connection was made to the lower part of the exhaust elbow. It became necessary to dig a pit 6 feet 6 inches deep in the basement floor, as the distance from the lower part of the exhaust elbow down to the suction of the pump should not be less than 4 feet.

As the sketch shows, the centrifugal circulating pump is placed on the same shaft as the wet-vacuum pump, both being driven by a turbine, the exhaust of which is used for heating the feed water. The circulating pump, having a capacity of 5000 gallons per minute, is connected to the water supply by a 16-inch suction and discharges through a 14-inch pipe to the condenser.

The dry-vacuum pump was placed on the generator floor. A 5-inch suction is divided into two branches, and connected to the top of the condenser, one on each side of the tube-supporting plate.

The equipment was designed for a 28-inch vacuum. A 5-inch gate valve was placed on the suction flange of the pump for testing purposes.

GERHARD KELSTRUP.

Brooklyn, N. Y.

Isolated Plant Owners Responsible

As far back as I care to trace them, I have read articles in POWER dealing with the central station versus the isolated plant. Nearly every writer believes that the incompetence of the engineer in charge is responsible for isolated plants being taken over by the central station.

I desire to briefly consider other reasons that have arisen in my own experience.

I believe that the owners or managers of many isolated plants are as much responsible for the poor economy shown as their engineers. An engineer may know that his plant is not running economically, but if the "powers that be" will not supply the necessary equipment or make the needed changes or repairs, I do not see how the engineer can produce economical results; nor do I think it fair to blame him if he cannot produce good results from poor or incomplete apparatus.

I ran a certain electric-lighting plant for some time. The plant consisted of an 80-horsepower boiler carrying steam at 95 pounds gage pressure; an 86-horsepower slide-valve automatic engine, a 37½-kilowatt alternator with its exciter and an arc machine carrying twenty-six 2000-candlepower open-arc lamps. The load on the alternator averaged about 15 kilowatts and the run was from sunset to midnight, averaging about seven hours the year around. To do this we used about 40 tons of coal per month. The water went to the boiler at a temperature of about 85 degrees in summer and from 50 to 75 degrees in winter. The engine exhausted to the atmosphere through a small closed heater that was fitted with six 1-inch tubes which had to take care of the exhaust from a 4-inch pipe. A ½-inch bleeder from the steam chest to the exhaust pipe was kept partly open all the time and when I put a steam gage on the exhaust pipe, it showed 12 pounds back pressure.

I advised installing an open heater and got figures on an outfit. With an expenditure of $250 I could buy and install an equipment that would reduce the fuel expenses one-half. I presented the figures to the company and was promised that they would take the matter up at once; that was over three years ago. I left the plant over a year ago and the conditions are still the same.

In another plant the manager buys the oil. The engineer asked for another grade of oil as the oil he was then using was too light for that particular engine. The manager informed him that he had been buying oil and grease for over 30 years and that he knew what he wanted as well as anybody. Yet it was necessary to feed the oil almost in a stream in order to keep the engine running quietly.

Many men advocate as a means of cutting down expenses the installation of a CO_2 recorder, a draft gage and several other instruments as well. All this is good, but who is going to install them? I do not think that very many engineers of moderate-sized plants can afford to buy them outright themselves and I do not know of very many owners of small- or medium-size plants who would spend the money to get them; in fact, a man is lucky to find a plant of this description with enough tools to make the ordinary repairs. Generally an engineer has to carry a small machine shop with him with which to run a plant after he does get charge of it.

Now and then, instead of prodding the engineers, although some of them may need it, I would like to see a movement started to stir up the managers and owners of plants, especially of plants where the central station is trying to get in. Get them to take enough interest and pride in their equipment to at least coöperate with the engineer in trying to get the best out of the plant that is possible.

I know that if I have charge of a plant and the owner will coöperate with me, that there will be no danger of the central station getting the job.

A. A. BLANCHARD.

Leesburg, Fla.

Questions Before the House

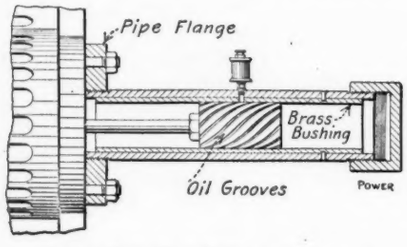
Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Tail Rod Stuffing Box

The accompanying sketch shows what I consider a better way of getting the result described by Mr. McGahey on page 705 of the November 7 issue.

By using a blind bonnet no packing is required, and as the wearing surfaces are large and can be well lubricated the arrangement will relieve the eccentric of some work.

As the shoe wears down, it may be turned around so as to bring another side to the bottom, and as the holes in the bonnet are interchangeable it also can be turned around. A new oil hole will



THE TAIL ROD STUFFING BOX

have to be drilled and the old one plugged up. The bonnet can be made from a piece of extra-heavy pipe and a suitable flange and cap, with a brass bushing driven into the pipe and peened. The shoe is of steel.

The bushing should be short enough to allow the shoe to travel over the ends and not wear shoulders in it.

The bonnet may be covered with asbestos, with a sleeve made of sheet iron to slip over it. This will reduce condensation and improve the appearance.

CHARLES BENNETT.

Chicago, Ill.

Air Compressor Running Under

In the October 31 issue, John S. Leese shows four diagrams of air compressors running under, and shows by arrows the forces acting on the guides.

In Fig. 1 is shown a tandem machine. The crank and crosshead are past the center, the steam pressure is at about the maximum and the air pressure is rising. The engine has reached its maximum speed for that stroke and is, therefore, not storing any more energy in the flywheels, so the force on the crosshead is neither up nor down. But a little further on in the stroke, the force is down, due to the inertia of the flywheels, the increasing air pressure and decreasing steam pressure. The flywheels must do their work by pushing the crosshead during expansion and over the dead centers.

In Fig. 2, two machines face each other. The diagram shows the machines in mid travel; the steam piston is under maximum pressure and is pulling the flywheels and air piston; therefore, the pull is upward on both crossheads, and remains so in every point of the strokes.

In Fig. 3 is shown a twin machine. The pull on the crosshead is up on the steam end and down on the air, running under or the opposite running over.

JAMES JOHNSON.

Hackett, Penn.

Leaky Corliss Valves

It is true, as J. O. Benefiel says on page 750 of the November 14 issue, that most, if not all, Corliss valves leak more or less, and while I do not think it is absolutely necessary that such valves should be perfectly tight, I do think that they could be better than found in most places.

It is possible to so make Corliss valves that they will not leak under pressures met with in practice, but it would probably cost more than would be saved in steam for quite a long time.

As generally fitted, the procedure is like this: The valve chambers are bored out to size, parallel and smooth, and if ordinary care and skill are used, the job will be good so far as the chambers are concerned.

Next, the valves are turned off in a lathe to fit the chambers into which they are to go. In my opinion, and from observation, the valves are usually turned too small to make a steam-tight job. It is thought advisable—and I believe it is—to provide for Corliss steam valves lifting from their seats, in case of a dose of water getting into the engine cylinder. This is usually accomplished by making the valve a trifle smaller than the bore of the chamber into which it is to go. While it does not look as though it would leak when fitted that way, yet it is sure to do so. Some seem to think the valves will wear down and become tight, but my experience has been that they will not become tight when made and fitted in the way described.

However, by turning the valve so that it will be a tight fit in the chamber, so tight that it cannot be rotated by hand, and then easing off the upper semi-circumference at each end of the valve to permit the valve to lift from its seat, as before referred to, a properly fitted and practically steam-tight valve will be had. In this case, the valve will wear down tighter because it will have a greater bearing surface to begin with, which is lacking in the manner of fitting the valves to which I first referred.

It is not an expensive job to ease off the upper half of the circumference at each end of the valve, and it is only at the ends where the easing would have to be done. I have tried this method and got the best results from it.

CHARLES J. MASON.

Scranton, Penn.

Christie Air Steam Engine

I was interested in the discussion in POWER of the Christie air-steam engine. About eighteen months ago one of my clients asked for a report on the Christie engine as he was thinking of investing in some stock. After looking over the prospectus, I wrote to the Christie company, telling them that there were some gross misstatements in their literature. They replied by sending me their latest printed matter and inviting me to point out the misstatements, as the prospectus had been out some time but had never been criticized.

I called their attention to the fact that they figured the efficiency of their engine from the formula $\frac{T-T'}{T}$, which is, of course, the efficiency of an engine working on the ideal or reversible cycle. Yet they claimed this efficiency, which cannot be obtained.

Further, in the diagram illustrating the cycle of operations, it was made to appear that atmospheric pressure was made to do the work of exhausting the working medium. As a matter of fact, there is simply added an extra cylinder in which the pressure on each side of the piston is balanced; thus they have simply added an extra piston which must be pulled along by the engine.

Then, the statement was made that the compressed air in the end of the cylinder fills the clearance, as it is termed,

and thus avoids the necessity of filling the clearance with steam. "This eliminates steam-engine clearance loss." In the next paragraph, Dalton's first law is stated thus: "The pressure, and consequently the quantity of vapor which saturates a given space, are the same for the same temperature, whether the space contains a gas or is a vacuum." These two statements are, of course, contradictory, as it will take as much clearance steam as if there were no air present.

Further, Mr. Christie lost sight of the fact that, when the steam valve opens, the boiler, steam pipe and engine cylinder become one vessel and a rapid diffusion of the air takes place into the steam pipe; consequently the air pressure in the cylinder drops during the admission of the steam and he does not have all the air expanding in the cylinder that was compressed there. Hence, for a time at least, the engine must work as an air compressor to pump air into the boilers.

After a careful consideration of the whole matter, I reported that, while a mixture of steam and air has some thermodynamic advantages as a working fluid, they are probably more than offset by the losses incident to the complicated mechanism used by the four-stroke-cycle air-steam engine to obtain them.

GEORGE L. SULLIVAN.

Bozeman, Mont.

Sand for Hot Bearings

The writer has read with considerable interest the articles which have appeared in the last few issues of POWER under the above caption and was amazed to learn that there was more than one side to the question. The rank and file in the vast army of stationary engineers would, almost to a man, condemn sand in any form in and about the engine room.

One writer, with a number of years in the marine service to his credit, stated in all sincerity that sand was considered as much a part of engine-room supplies on salt water as were oil and waste. Another man, equally as broad in his marine experience, placed the first writer's story on the shelf beside "The Classical Works of Ananias" and "Autobiography of Judas Iscariot," and with equal boldness and sincerity stated that sand as a lubricant was taboo on all occasions.

There may be times when sand is the panacea for hot boxes, yet in all this good-natured and highly appreciated controversy, I do not recall that any of the advocates of the sand treatment has advanced a theory or has given a reason as to why sand will cool a hot bearing—if it does.

It is a well known fact that the chemical composition of various metals used for both shafts and bearings, has much to do with their running conditions. One occasionally finds several bearings running under exactly similar conditions yet with a wide difference in temperature.

The writer once observed a troubleman look over the bearing on a generator, the shaft of which was perhaps 6 inches in diameter. This bearing had always run warm and the temperature increased with time until it was necessary to call in a man from the shop. He removed the bearing and the shaft was found to be as smooth and as perfect as could be desired.

This, the expert claimed, was the real trouble, it was too smooth, and much to the surprise of those present he filed the entire surface of the shaft in the bearing quite liberally, and when the machine was assembled and again placed in operation the bearing ran cooler than it ever had done before. The expert stoutly maintained that the shaft was so smooth that the oil would not follow it and the filing provided the necessary means of lubrication.

Perhaps this is why sand is sometimes a good thing for hot boxes, for the same reason that lemon juice is good for a sore throat. Let the adherents of the sand treatment speak up. We would all like to know the conditions under which sand is used in bearings and the theory advanced for its use as well.

GEORGE H. WALLACE.

Racine, Wis.

Show versus Efficiency

With the article by William E. Dixon, "Show versus Efficiency," in the November 7 issue, I am heartily in accord. There is, however, another side to this question besides that of keeping the brasswork polished. As is stated in an editorial in the September 26 issue, the waste in coal owing to this show is a very material item; and while an attractive-looking engine room and boiler room is a comfort to the eye, it is not always economical. Polished brass or iron or painted iron is not economical.

All piping carrying hot water or steam should for the sake of economy be covered with a nonconducting material, even at the sacrifice of appearance. It is not necessary that the effect should be bad or even poor, as pipe covering, if properly installed, can be made to look very attractive; and for the sake of saving not only labor for the employees but coal for the owner, all pipes carrying any amount of high-temperature water or steam should be covered, the thickness depending on the temperature of the pipes and the amount of radiation which might come from them.

Particular attention should be paid to covering all valves and all flanges, as these are far more effective as regards dissipating heat than the plain pipe.

HENRY D. JACKSON.

Boston, Mass.

Water in Red Hot Boiler

In a recent number a correspondent asked: "Will turning cold water into a red-hot boiler cause an explosion?"

Anything that will cause a sudden local change of temperature of any part of a boiler will tend to strain that part unduly, due to sudden local contraction or expansion. Whether an explosion will be caused, either immediately or in the future, will depend entirely upon the condition of the boiler, the parts affected by the strains and the damage done.

Allowing cold water to enter a hot boiler is not an infallible test for ascertaining whether or not it would explode in actual practice under like circumstances.

E. H. BENDEL.

Chico, Cal.

Filling Oil Storage Tank

For the benefit of a few correspondents who advocate using compressed air to unload oil-tank cars, I submit this extract, from the notices sent out by the Union Tank Line Company:

"Warning! Keep lights and fires away. Air pressure *must not be used* in unloading tank cars."

There is also other useful information furnished on these notice cards, but I believe the above is all that pertains to the point under discussion. In our case, if we cannot empty the car in the usual way, we use a pump and a suction line with swivel joints, the joints being provided with stuffing boxes so that they may be kept tight with packing.

E. H. LANE.

Kansas City, Mo.

Graft

I have read with interest the articles appearing from time to time on the subject of graft. Some salesmen are so clever as to lead a man into "deep waters" before he realizes it. An experience which I once had illustrates my point.

I was purchasing boiler compound from a certain company, and as I do not smoke I always refused the cigars offered by the salesman. One day he said that he was going to bring me a pocket knife, stating that the company had some it was distributing among its customers. Supposing that it was a knife bearing the company's name and advertisement, I thanked him and told him it would be acceptable. When the knife came, to my surprise it was a nice little pearl-handled affair which had been purchased at a local hardware store.

Next he met me as I was going to lunch, and insisted that I eat lunch with him, which I could not very well refuse to do. For Christmas I received a silver-mounted brush. Several like courtesies were offered, generally when my com-

pany was nearly out of the material he was furnishing.

Other companies had been furnishing some of the material, and this salesman was anxious to get all the business for his company. He therefore set to work to secure an advance order or contract for a year's supply. He said:

"My sales for the last year amounted to $12,500. The company has offered to establish a branch office, putting me in charge, if I will get $16,000 worth of business this year. The price of the goods we have been selling you is 6 cents per pound; three packages would come to $180. If you will give me an order for three packages, I will make you a price of 5 cents per pound. My commission on this order will be $27. I am after orders, not commissions, so that I may get that branch office; if you will give me this order, I will make you a personal present of my commission."

Although I refused the offer, he insisted that it was not a bribe but simply a present from him; it was not the company's money.

R. L. RAYBURN.

Kansas City, Mo.

I have been following with interest the discussion on the subject of graft which has been going on in POWER.

There is graft in the sale of a good many articles used in engineering, and in many cases consulting engineers and others in control of the purchase or use of supplies and other materials are approached. Very often the selling concern makes a price to the user which contains a certain allowance for the "graft" or commission to the party controlling the purchase, and frequently the selling price will not be reduced and no deduction will be made if the grafting commission is refused.

In dealing with a case of this kind, insist that the commission be given in the form of a check payable to order. Then the recipient is in a position to pass this check, properly indorsed, to the credit of the purchasing concern and the fact is recorded in such a way that no question can ever arise. A further advantage of this method of handling the matter is that the indorsement upon the check can be so written as to inform all who handle it why it passed.

A. D. WILLIAMS.

Cleveland, Ohio.

I have read the various talks on "Graft" that have appeared in POWER from time to time for the past year, and I must say that I cannot believe that there is anything to it, from what experience I have had. I have found very little, if any, chance for an engineer to do any grafting, as it is about all that most of us can do to get what we actually need for our plants.

Furthermore, an engineer would be a fool to change his satisfactory supplies to an unknown line for the sake of a few cents graft money. Take packing, for instance; the average plant will not use more than $25 worth a year. Can anyone imagine any salesman fool enough to give a great deal of graft money for the privilege of furnishing such an amount, or any engineer foolish enough to risk his reputation and chances for such a pittance as he would probably get out of it?

I believe that if there are "crooks" in the profession, they are after larger game than packing.

I have been an engineer for nearly 20 years and have never been offered a bribe by any salesman for anything. I have always found the salesmen to be clever, upright men.

I never knew but one grafting engineer, and the last time I saw him he was pushing a small two-wheeled cart with a sack on it, cleaning fertilizer off one of our city streets.

D. W. SCARBOROUGH.

Richmond, Texas.

A Twenty Four Hour Log

In compliance with Mr. Ward's request in the issue of November 1, I submit the following calculations and suggestions:

Assuming an average boiler pressure of 120 pounds gage, with a feed-water temperature of 274 degrees, the factor of evaporation would be

$$F = \frac{H - t + 32}{970.4} = \frac{1193.4 - 274 + 32}{970.4} = 0.98$$

The equivalent evaporation per hour would be

$$\frac{382{,}800 \times 0.98}{24} = 15{,}631 \text{ pounds}$$

from and at 212 degrees, which would equal 453 horsepower developed with the two boilers, or 226.5 horsepower per boiler; this is 82.36 per cent. of the rating developed.

The coal apparently runs about 9.2 per cent. ash, which, it may be assumed, calls for a grade of bituminous coal of about 13,170 B.t.u. per pound. To raise one pound of water from 274 degrees to the boiling point corresponding to 120 pounds pressure gage, and evaporate it into steam at the same pressure, requires

$$H - t + 32 = 1193.4 - 274 + 32 = 951.4 \text{ B.t.u.}$$

An evaporation of 11 pounds of water per pound of coal as fired gives

$$11 \times 951.4 = 10{,}465.4 \text{ B.t.u.}$$

absorbed by the boiler per pound of coal. The efficiency of the boiler and furnace is then,

$$\frac{10{,}465.4}{13{,}170} = 79 \text{ per cent.}$$

based on the coal as fired. This is higher than the average.

Based on 12 square feet of heating surface per horsepower there are

$$12 \times 275 = 3300 \text{ square feet}$$

per boiler, or 2.41 pounds of water evaporated per square foot of heating surface per hour. According to the data given there are 50 square feet of grate area per boiler. Based on 50 square feet of heating surface to 1 of grate area, the boilers would stand 66 square feet of grate area.

I believe that with this ratio of grate area, and the installation of an efficient mechanical stoker with a forced draft of about 2 inches of water, Mr. Ward should be able, with the high temperature of feed water, to evaporate at least 12 pounds of water per pound of coal as fired. Assuming that the peak load is not greater than 550 horsepower, or 200 per cent. of builder's rating, this load of 462 horsepower, which would be an average of 168 per cent. of rating, could be carried with one boiler, resulting in a still higher degree of overall efficiency and lower cost of operation.

This would require an average combustion of about 20.2 pounds of coal per square foot of grate area per hour. This is not considered excessive with some types of stoker, as the air supply necessary to furnish the required amount of oxygen for a practically complete combustion is controlled automatically in proportion to the coal delivered to the furnace.

The electric load shows the plant to be running at a load factor of only 10.4 per cent., which is not considered economical operation; but there are cases where a company's prospects of expansion justify this loss. With the generator operating at 90 per cent. efficiency, and the turbine proportionately efficient in steam consumption, I believe that Mr. Ward has nothing to fear from the central-station people. From my limited experience the results he is getting look good.

J. L. KEZER.

Bradford, Penn.

Centrifugal Pump Capacity and Speed

In the issue of November 14, in a criticism of an article by T. W. Holloway on "Centrifugal Pump Capacity and Speed," N. C. Hurst makes a gross error when he derives the formula

$$h = \frac{V^2}{g}$$

from that which he uses for centrifugal force.

The original formula which he gives for centrifugal force at unit radius and with unit weight is correct. This formula is $F = \frac{V^2}{g}$. The formula for the velocity of falling bodies is $V = \sqrt{2gh}$. From this, squaring both sides, $V^2 = 2gh$. Substituting in the formula for centrifugal force we have $F = \frac{2gh}{g} = 2h$. Therefore, $F = 2h$, and shows that "F is proportional to" but that it is *not* equal to h.

From this it is evident that, from the formula of centrifugal force, can be derived $2h = \frac{V^2}{g}$, or

$$h = \frac{V^2}{2g}$$

This formula can be derived directly from the law of falling bodies.

Mr. Hurst speaks of the perfect pump. The law of falling bodies applies exactly to the "shutoff" pressure of the pump. The working discharge pressure is dependent upon many other factors, but the pressure with the discharge closed will follow the law accurately.

F. G. WHEELER.

Trenton, Mich.

Efficiency of Reciprocating Engines

A paper on the "Efficiency of Reciprocating Engines," by K. Heilmann, the main features of which (translated from the German) were published in POWER for October 31, is one of the most remarkable contributions to our knowledge of steam that has been published since the days of Willans. These experiments were made by a German manufacturer, principally to compare the relative value of the "uniflow" type of cylinder fitted with poppet valves with the tandem-compound type with piston valves, both using steam of high pressure with high superheat, the tandem-compound engine having the steam superheated a second time as it passes from the high- to the low-pressure cylinder.

The notable features in these experiments are the high pressures used, about 200 to 220 pounds, and a high degree of superheating, reaching a temperature as great as 930 degrees Fahrenheit. These engines were of the "Locomobile" type of construction, in which the engine, boiler, superheater, condenser and pumps are all consolidated into one unit, the steam cylinders being placed in the smokebox of the boiler, or a continuation of it, so that they are bathed with the waste gases as they pass out to the chimney.

The tests were made under varying conditions; the engines were operated condensing and noncondensing, under loads varying from about 60 to 150 indicated horsepower; then with varying degrees of superheat, from 0 to over 500 degrees, and finally with varying degrees of vacuum. A valuable feature of these experiments lies in the fact that they have been conducted in a realm of pressure and superheat which is outside of usual practice, and therefore point out the direction in which it is possible to work in securing superior economies. The article as it appeared in POWER gives most of the data of the original article which was published in the *Zeitschrift des Vereines Deutscher Ingenieur* for June 10, 17 and 24, 1911.

It is interesting to note some of the incidental features of these experiments, which were not dwelt upon in the abstract presented in POWER.

It was found that in using high superheats that less difficulty with lubrication was experienced with piston valves than with the poppet valves of the "uniflow" cylinder. In the "uniflow" cylinder the steam valves were maintained at an extremely high temperature, the low pressure and temperature steam passed out through the center of the cylinder. With the piston-valve engines the steam flowed back through the valves at a lower pressure and temperature than when admitted, so that the average temperature of the valves and seats was kept relatively low and much below the temperature of the initial superheated steam. It was found that a residue from the burned oil was deposited on the poppet valves and had to be removed from time to time. This residue was not found with piston valves.

In these experiments, both condensing and noncondensing, the tandem-compound engines developed a higher economy than the single "uniflow" cylinder engine. On the other hand, the performance of the single-cylinder engine was remarkable, and the practical benefits secured by superheated steam were most apparent in connection with this design. One of the principal reasons why the "uniflow" cylinder is less economical than the compound was the fact that the terminal pressures were much higher for the same horsepower, so that more steam at high temperature was thrown away into exhaust without doing any work. It is interesting to note that the steam consumption with the "uniflow" cylinder noncondensing was very uniform over a great range of power, much more so than is the case with the tandem engine.

Investigation of the strains developed in both types of engine is recorded in this paper. A "uniflow" cylinder 13.6 inches in diameter and a low-pressure cylinder of one of the compounds 16 inches in diameter were taken for comparison. When working each at the same piston speed under about 190 pounds steam pressure the strains on the bearings and frames of the "uniflow" engine were about 2.4 times greater than on the tandem engine developing the same power. This means that for the "uniflow" engine the pins, main bearings and slides have to be much larger, and the frame much heavier to withstand the greater strains. Its flywheel also has to be much heavier, as greater amounts of work have to be absorbed and delivered by it.

In conclusion, these experiments show that a steam engine can be operated at extremely high economy with a thermal efficiency of the engine alone of about 26 per cent., and of the engine and boiler together of 22 per cent. When it is remembered that coal in most places furnishes more heat units for a dollar than any other form of fuel. it places engines of this type in the front rank of economical power-producing machines, a brake horsepower-hour having been developed with an expenditure of only 12,000 B.t.u.

The writer is of the opinion that the extreme temperatures used in these experiments are experimental, and have not been largely put in practice, but they represent an advanced step in this direction. In this connection it should be remembered that engines of the locomobile class have shown wonderful economies, with even less superheat, and high economies have been secured with small, as well as large, units. It would be advantageous if this article could be carefully translated throughout, so that every professor of steam engineering should be made familiar with it, as it throws new light on the possibilities for the steam engine. It would not be a bad exercise to give this article in the German language to students, and have them work out and tabulate the English values with their slide-rules.

J. B. STANWOOD.

Cincinnati, Ohio.

License Laws

Mr. Leiper's letter in a recent issue on the Philadelphia license laws brings to my mind similar laws in the city of Detroit, Mich. About a year ago, having secured a position in that city, I went to the city hall to be examined. The clerk handed me a blank, which I had to have signed by five engineers then employed in the city, stating that they knew me, that I had had experience and was competent as an engineer.

Now, if five engineers knew me, and knew my ability and were willing to swear to it, why did I need an examination or what did the examiner expect to find out? Also, how could one get his first papers if he could not get them until five engineers knew his ability as an engineer, when one was not allowed to act as such? The ordinance was plainly unconstitutional, but I had no friends or funds to fight it. I was denied the right of examination, notwithstanding that I held an Iowa and a Government license.

I hope some Detroit brother comes out to defend the ordinance, because I want to hear the other side of the matter. I was informed that the engineers' union was very strong. My idea of a union is a body of men working to better conditions and to educate rather than to shut out competent men. Many city ordinances are drawn up by men who have not the proper experience and for that reason a union, to my mind, should try to remedy such defects in city laws that arise from this cause.

ROY V. HOWARD.

Tacoma, Wash.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Engine Horsepower

What is meant by the horsepower of an engine? What is mean forward pressure? What horsepower will an 11x24-inch engine develop at 90 revolutions per minute and 125 pounds pressure?

C. Z. L.

A horsepower is 33,000 foot-pounds per minute.

The number of foot-pounds developed by an engine per minute is the number of feet passed through by the piston multiplied by the average unbalanced force; that is, the mean effective pressure upon the piston.

The total mean forward pressure is that quantity per square inch multiplied by the area of the piston in square inches.

The horsepower then is

$$\frac{\textit{Mean effective pressure} \times \textit{area} \times \textit{piston speed}}{33{,}000}$$

The area of an 11-inch circle is 95 square inches.

The piston speed of an engine with a 24-inch or 2-foot stroke running 90 revolutions per minute is

$$2 \times 2 \times 90 = 360 \textit{ feet}$$

(2 feet per stroke, 2 strokes per revolution, 90 revolutions per minute).

The mean effective pressure is more difficult to get. It depends not only upon the initial pressure but upon the point at which the steam is cut off, and upon the back pressure, whether the engine is run condensing or noncondensing, etc. In a table of hyperbolic logarithms find the logarithm of the ratio of expansion; that is, of the number of times the steam is expanded. Neglecting clearance, this would be 4 for a quarter cutoff, 3 for one-third cutoff, etc. Add 1 to the logarithm and multiply it by the absolute initial pressure found by adding the barometric pressure to the gage pressure. Divide the product by the ratio of expansion and the quotient will be the mean forward pressure.

For example, suppose the ratio of expansion is 4, the hyperbolic logarithm of which is 1.3863. Add 1 to this, making 2.3863. Suppose the barometric pressure to be 14.7 pounds, the absolute initial pressure would be

$$125 + 14.7 = 139.7$$

say 140 pounds. Then

$$\frac{2.3863 \times 140}{4} = 83.5 \textit{ pounds}$$

Now what is the back pressure above absolute zero? Suppose the engine is noncondensing and has such compression that the average back pressure is 10.3 pounds above the atmospheric, making an average absolute back pressure of

$$10.3 + 14.7 = 25 \textit{ pounds}$$

Take this from the 83.5 and 58.5 will be had. This is what a perfect indicator diagram within these limits of pressure would give. One's own judgment must be used in deciding how nearly the engine in question would come to making a perfect diagram. Knocking off 3.5 pounds for round corners, etc., and calling the mean effective pressure 55 pounds, the horsepower would be

$$Hp. = \frac{55 \times 95 \times 360}{33{,}000} = 57$$

Water in Low Pressure Cylinder

Under what conditions can the low-pressure cylinder be wrecked with a jet condenser?

E. B. M.

Suppose a condensing engine to be running with the usual vacuum. If the throttle valve be closed the engine will make a few revolutions; there will be a vacuum in the cylinder of the engine just the same as in the condenser. Now suppose the air pump to be stopped without shutting off the injection water. The water will fill the condenser and exhaust pipe and enter the cylinder of the engine through the open exhaust port. In the cylinder it will meet the moving piston, which cannot push all the water back whence it came. When the exhaust valve closes a certain amount of water will be entrapped within the cylinder, and as the piston moved by the flywheel cannot stop and the water in the cylinder cannot be compressed, some part of the engine must give way.

Lubricating Oil in Boilers

What determines the size of a drop of liquid? What might be expected to occur if lubricating oil is introduced into a boiler with the feed?

A. B.

The volume of a drop of liquid is determined by the size of the orifice, the pressure, the temperature and its viscosity. Lubricating oil introduced into a boiler is apt to cause the seams, tube ends and rivets to start leaking. A large quantity of oil in a boiler will lodge on the metal, preventing the water from coming in contact with the surface affected by the oil. If the boiler is forced a bagged or blistered crown sheet or tube will result.

Setting Valves on a Snow Duplex Pump

How are the steam valves set on a 4½x2¾x4-inch Snow duplex pump?

R. J. S.

The steam valves on this type of pump have no outside lap; hence in a central position they just cover the steam ports. It should also be remembered that the piston on one side actuates the valve on the other.

To set the valves, first move the pistons to their extreme head-end positions and mark the piston rods at the faces of the stuffing-box followers. Then place the pistons in their extreme positions in the other direction and similarly mark the piston rods. Now make a mark on the piston rods exactly half-way between the first two marks and place piston No. 1 so that this center mark will come just flush with the stuffing-box follower. The piston is now at mid-stroke.

Take off the steam-chest cover of No. 2 cylinder, disconnect the link from the head of the valve rod and place the valve in its central position. If only a single valve-rod nut is used, place this mid-way between the jaws on the back of the valve and screw the valve rod in or out until the eye on the rod comes in line with the eye on the link, then reconnect.

If instead of the valve being moved by one nut on the rod between the jaws, two nuts are employed, one on either side of the jaws, then these nuts should be so adjusted as to allow about $\frac{3}{16}$ inch lost motion on each side of the jaw. Then reconnect as before.

Piston No. 2 may now be placed on center and No. 1 valve set in a manner similar to No. 1.

In 1910, Pennsylvania employed 169,497 miners in its anthracite and 175,403 men in its bituminous mines, the production per man in the former being 498 short tons in 229 days and in the latter 825 short tons in 238 days.

Annual Meeting of American Society of Mechanical Engineers

The annual meeting of the American Society of Mechanical Engineers was held at the Engineering Societies Building, New York, Dec. 5 to 8. In attendance and in the interest and variety of the papers presented it was fully up to the high standard of recent years.

On Tuesday evening the retiring president, Col. E. D. Meier, presented his address, which dealt with "The Engineer in the Future" and was abstracted in our last issue. At the close of his address he was presented with the portrait, a photograph of which also appeared in our last issue, the presentation being very fittingly made by Walter M. McFarland. The newly elected president, Alexander C. Humphreys, was then introduced and gracefully acknowledged the high tribute which had been paid to him by his predecessor and assumed the responsibilities of the head of the society for the coming year.

The company then adjourned to the society's rooms, where the retiring and incoming presidents received and a collation was served.

The session of Wednesday morning was largely devoted to the internal affairs of the society. The net increase in membership during the past year has been 108. The officers announced as elected for the coming year are: President, Alexander C. Humphreys, president of Stevens Institute of Technology; vice-presidents, William F. Durand, professor of mechanical engineering at Stanford University, Ira N. Hollis, professor of engineering at Harvard University, and Thomas B. Stearns, of Denver; managers, Charles J. Davidson, of Milwaukee, Henry Hess, of Philadelphia, and George A. Orrok, of New York; treasurer, William H. Wiley, of New York.

The usual luncheons were served in the interims between the morning and afternoon sessions, affording opportunity for reunion and social intercourse.

On Wednesday evening the society was favored with a lecture by Dr. Robert Simpson Woodward, president of the Carnegie Institution at Washington, on "Geo-Dynamics, or the Mechanics of the Formation of Worlds."

On Thursday afternoon an invitation was accepted from the White Star Line to visit the "Olympic," the largest passenger steamer afloat. On Thursday evening a reunion was held at the Hotel Astor in honor of the newly elected officers and visiting members of the society and their ladies and guests, which was attended by upward of seven hundred.

On Friday a large number of the members visited the Edison laboratories at Orange, N. J., and numerous other excursions to points of local interest were participated in by smaller groups.

The papers produced by the meeting which will most interest POWER readers were those dealing with the test to destruction of two 72-in. horizontal tubular boilers, by James E. Howard, and the remarkable test of two 2300-hp. boilers at the Delray station of the Detroit Edison Electric Co., both abstracted in our issue of Dec. 5, the discussions of which will appear later, and the proceedings of

The Gas Power Section

The session of the Gas Power Section, held on Thursday morning, was characterized by the presentation of four highly interesting papers and a limited discussion of two of them. The time available was much too short for adequate presentation and discussion.

GAS POWER IN 1911

The session opened with the annual address by the chairman, Prof. R. H. Fernald, in which the developments of the year now closing were interestingly reviewed. In the address, Prof. Fernald pointed out that in Europe engines are being built to develop 1500 hp. per cylinder, working on the four-stroke cycle, and 2000 hp. working on the two-stroke cycle.

Referring to the European practice in Diesel-engine construction, he said that in Swiss electric stations there are Diesel engines of 2000 hp. each. These are, of course, multicylinder, but the power per cylinder is increasing rapidly, and "it will not be long before 1000 hp. developed in one cylinder will be thought nothing extraordinary."

Regarding the utilization of waste heat from the gas engine, he said that, although exhaust-heat boilers are in satisfactory use, it is the general opinion that the most efficient method is a combination gas and steam engine. In such a combination the gas engine would be made less efficient than normal by using a lower compression than usual and running with less ignition advance. The heat economy would go up to about 12,000 B.t.u. per brake horsepower, but the steam boiler would utilize the increased heat carried out in the exhaust gases. It is estimated that for each brake horsepower developed by the gas part of the combination, 4 lb. of steam per hour would be available from exhaust-heat recovery.

The proposed steam cylinder would be of the uni-directional-flow type, with exhaust ports in the center of the cylinder, covered and uncovered by the piston. For this type of engine, Prof. Fernald said, an economy of 12 lb. of steam per horsepower-hour might easily be obtained. Three-fourths of the total output, therefore, would be due to gas and one-fourth to steam. The combined economy of the composite unit, he said, would be as low as 9000 B.t.u. per brake horsepower-hour.

Concerning what Prof. Bone terms "surface combustion," Mr. Fernald said that the latest report from this method was to the effect that gas-fired boilers have evaporated 21.6 lb. of water per square foot of heating surface, showing a heat-transmission efficiency of 94 per cent. Deducting 4 per cent. to cover the power required to supply the air pressure leaves a net efficiency of 90 per cent.

Referring to the crude-oil gas producer, Prof. Fernald described briefly the Grine apparatus,* which is the latest development in that branch of the field, and in conclusion, he said:

> It is gratifying to note that each year eliminates many of the absurd prophecies regarding the elimination of practically all prime movers save the internal-combustion engine, and that the past year has been one of steady, conservative progress and development in the field that is of such keen interest to so large a percentage of the total membership of the American Society of Mechanical Engineers.

The first paper of the session was by H. R. Setz, and bore the somewhat ambitious title of "Oil Engines." The author reviewed the development of oil-engine design, describing briefly the salient features of the various types of oil engine, from the early Hornsby-Akroyd up to the latest Diesel. His review led up to a special form of engine designed by himself to work on the Diesel cycle. The paper will be abstracted in an early issue.

Following the presentation of Mr. Setz's paper, one by Forrest M. Towl was read in which the results of a test of an 85-hp. De La Vergne oil engine were given. This paper was printed almost in full in the Gas Power Department of POWER for Dec. 12.

Discussing Mr. Setz's paper, H. J. K. Freyn pointed out the fact that since the expiration of the Diesel patents, most of the important engine builders in Europe have taken up its manufacture, with the result that prices have been materially reduced. A certain four-cylinder engine built in France sells for $45 per horsepower, in sizes of 1000 hp. and over. He pointed out also that part of the explanation of the lower prices in Europe is the fact that skilled labor is cheaper there than here and also of a higher grade, by reason of the much greater number of years of experience.

Mr. Freyn counseled moderation in attacking the oil-engine problem and expressed the opinion that marine work will probably afford an immense field for oil power, because of the compactness of fuel and equipment, which increases

*Described on page 744, Nov. 14 issue of POWER.

the radius of action per unit of fuel-storage capacity and power-plant space.

Referring to the matter of fuel economy as between oil engines and producer-gas power plants, L. B. Lent pointed out the fact that geographical location has much to do with the relative economy; where oil is cheap coal is usually high, and *vice versa*. He presented the accompanying table showing the comparative prices of oil and producer-gas power, based on the consumption of ½ lb. of oil and 1 lb. of coal per brake horsepower-hour, and the same cost per unit of work for both kinds of equipment.

LENT'S TABLE OF COMPARATIVE COSTS

Cost of Oil per Gallon	Fuel Cost per Brake Horsepower-hour	Equivalent Cost of Coal per Ton
2c.	0.155c.	$3.10
2¼	0.174	3.49
2½	0.194	3.87
2¾	0.213	4.26
3	0.233	4.65
3¼	0.252	5.03
3½	0.271	5.42
3¾	0.290	5.81
4	0.310	6.20
4¼	0.330	6.58
4½	0.349	6.97
4¾	0.368	7.36

In closing the discussion of the oil-engine papers, Mr. Setz explained, in response to a question by Charles W. Baker, that the temperature of the injection air falls when the air enters the cylinder, and this is one of the difficulties encountered in building engines to run on heavy oils. This drop in the temperature of the injection air, upon entering the cylinder, is so great in some cases, he said, that it is difficult to ignite the oil, even at full load. One of the solutions of this problem, he stated, is to use light oil to produce ignition and follow it with a charge of heavy oil. Mr. Setz corroborated Mr. Freyn's assertion that the quality of workmanship in this country is, as a rule, not as high as in Europe. The manufacture of oil engines of the Diesel class, he said, requires greater precision in both machinery and men than is commonly found here.

The next paper was one by Prof. W. D. Ennis, on "Design Constants for Small Gasoline Engines." This related to automobile engines and was too mathematical for satisfactory abstracting. One of the features of the paper was the proposal of the formula:

$$\frac{Cd^2fS^{0.9}}{24{,}000{,}000} = \textit{Brake horsepower}$$

in which

d = Piston diameter;
f = A number (1.85 suggested);
S = Piston speed, feet per minute;
C = A "constant," ranging from 5970 to 11,008 in value.

There was no oral discussion of this paper, and Edwin D. Dreyfus then presented, in abstract, a paper on the "Tests, Construction and Working Costs of a 1000-kw. Natural Gas Engine," prepared by himself and V. J. Hulquist. The paper contained a brief description of a generating unit in the Allegheny plant of the American Locomotive Co. The engine is a twin tandem double-acting machine, with cylinders of 23½ in. bore and 33 in. stroke, rated at 150 r.p.m. The test showed a heat economy of 10,410 B.t.u. per brake horsepower-hour, at 81½ per cent. of rated load and at 1.7 per cent. above rated load, using natural gas of about 1050 B.t.u. per cubic foot. The mechanical efficiency of the engine was 68 to 80 per cent., according to the load; the lowest figure was obtained at 724 brake horsepower and the highest at 1220. At about full-load rating the mechanical efficiency was 78.2 per cent. With one half of the engine "dead" and being dragged by the other half, in addition to a brake load of 370 hp., the mechanical efficiency went down to 65 per cent. The average speed variation, from no load to full load, was 3.1 per cent.

The construction cost of the plant was only $80.18 per kilowatt of capacity, including the 1000-kw. generator, switchboard, building, land, etc. The total operating costs, including fixed charges, are given as below:

	Cost per Kilowatt-hour, Cents	
	10-hr. Day	22-hr. Day
Half load	1.263	0.859
Three-quarters	0.907	0.637
Full load	0.742	0.536

Discussing Messrs. Dreyfus and Hulquist's paper, Mr. Moultrop remarked on the low cost of the plant and said that it was much lower than figures with which he had become familiar through his work on the plant-operation committee. Mr. Freyn said that his experience had been that a large blast-furnace gas-engine plant could be installed for $90 or less, including the cleansing outfit, which usually costs about $10 per kilowatt of power-plant capacity.

Fate of Polytechnic Institute in Balance

For many years the institute, like many technical schools, has been operated at a loss, which has amounted to about $1000 per week. This deficit has been made up by the generous contributions of public-spirited men who have constituted the board of trustees. It has been proposed to raise a fund of $800,000, which would relieve all indebtedness and provide an income sufficient to care for the usual running expenses. Of this sum $520,000 has been conditionally subscribed by the trustees themselves; an additional $130,000 has been raised by subscription on the part of the citizens of Brooklyn.

To get this $650,000 already subscribed, $150,000 more must be given by Jan. 1. This probably means that the sum must be made up in small contributions from a large number of persons interested. The man who pledges himself to give $187.50 before Dec. 31, 1911, will be virtually endowing the Polytechnic with $1000.

The Polytechnic is doing good work in New York. It affords the opportunity for men to obtain in their evening hours precisely the same sort of high-grade technical education that the son of wealthy parents can obtain by the usual four years' undergraduate course. It is hardly conceivable that the engineers of New York will allow such a meritorious work to fail for lack of funds.

The National Gas Engine Association

At its annual meeting, held in Cleveland, Ohio, Dec. 5 to 8, the National Gas and Gasoline Engine Trades Association changed its name to the extent of omitting the words "and Gasoline" and "Trades," the result being as in the above heading.

The officers elected for the ensuing year are O. C. Parker, of La Crosse, Wis., president; H. W. Jones, of Chicago, vice-president; Charles O. Hamilton, of Elyria, Ohio, H. W. Bolens, of Port Washington, Wis., and O. B. Iles, of Indianapolis, Ind., members of the executive committee.

The meeting next June will be held in Milwaukee.

Liverpool Explosion

As often happens in the first dispatches of a severe accident, the loss of life in the recent Liverpool explosion is 23 instead of 33 persons, while the injured number 70 instead of 100, as stated in the Dec. 5 issue.

The cause is now attributed to the ignition of a mixture of dust and air rather than to a boiler explosion, as at first reported.

It appears, says the *Manchester Guardian*, that the atmosphere in the room was heavily charged with floating dust produced by the grinding of dry kernels, seeds or husks from which the oil had been expressed. A spark from a piece of metal trapped in a grinding machine might set fire to such a mixture, or it might be ignited by some accidental sparking in the electrical equipment, thus causing the violent explosion, which was accompanied by enormous sheets of flame, the hurling of heavy machinery from its place, and the rapid collapse of the building. Within the last few years the danger of dust explosions has been fully recognized in the case of coal mines, and it is very probable that even yet the imflammable character of other kinds of dust, such as are produced in many manufacturing processes, has not received due attention. Such lessons are, unfortunately, too often taught only by dreadful experience, as instanced in the Bibby & Sons oilcake mills.

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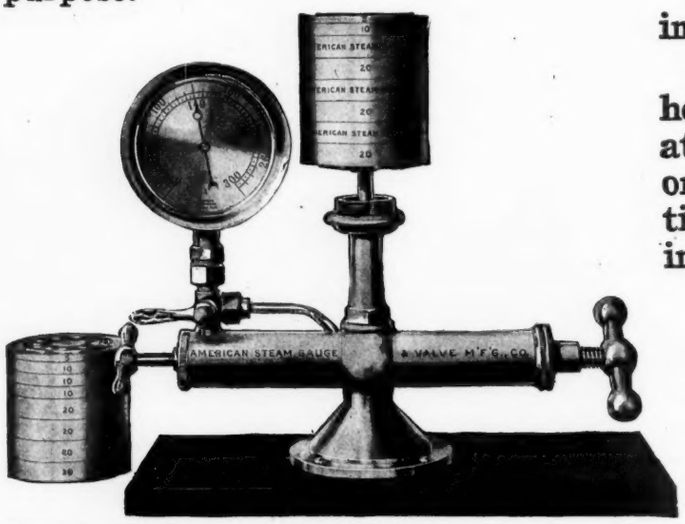

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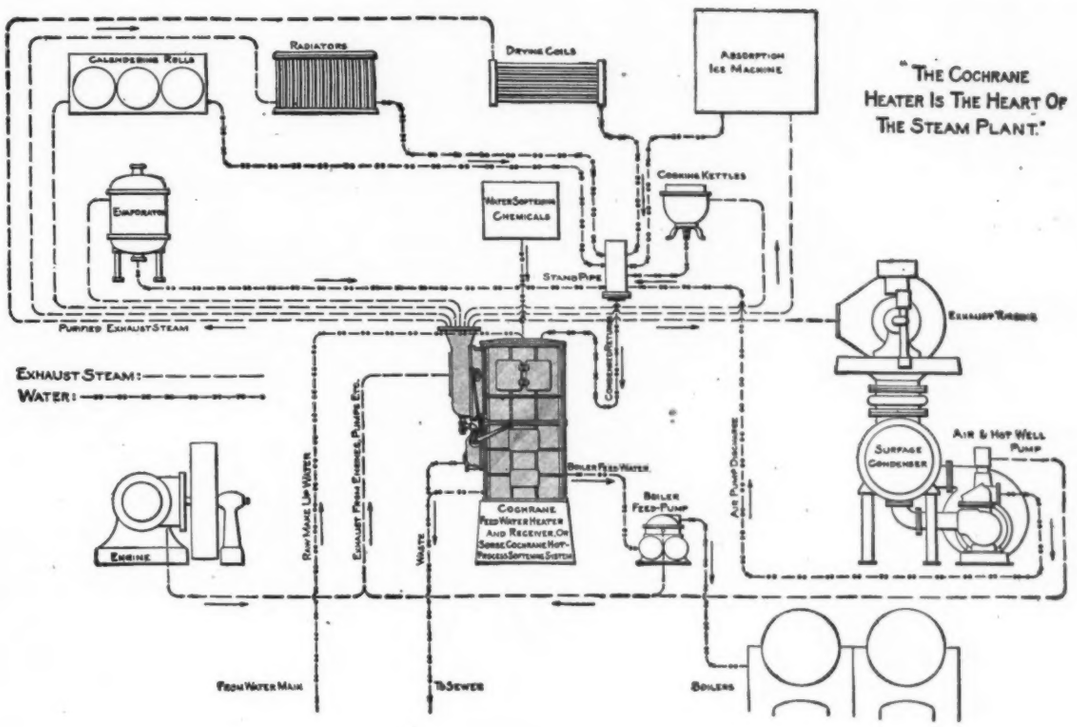

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For even after you have all of the independent devices, the combination will not be as convenient, compact or "fool proof" as is the Cochrane Steam-Stack and Cut-Out Valve Heater and Receiver.

The valves arranged in the separator and drainage trap of this combined heater and separator permit of cutting the heater out of circuit for cleaning or inspection, while the separator continues to supply purified exhaust steam to the heating or drying system, etc.

The two valves are connected to one valve gear, so that it is impossible to operate the one without throwing the other. Mistakes are therefore prevented and there is no danger of stalling the engine, or of turning steam in on a man engaged in cleaning the heater.

Nor of blowing up the heater by the discharge of live steam traps into the heater when the valve is closed, since the valve is held to its seat against internal pressure in the heater by springs only.

If you have some particular plant or conditions in mind, send us your data with a sketch, and we shall be pleased to have our Engineering Department suggest the best arrangement to meet your requirements. If you are interested in the subject, ask for a copy of our "*Exhaust Steam Heating Encyclopedia*, 15-E."

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